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THE
GEOGRAPHICAL REVIEW

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DRIFT IRON

A FORTUITOUS FACTOR IN PRIMITIVE CULTURE

T. A. Rickard

TO many primitive peoples in parts of the world remote from what we consider the centers of civilization the first man-smelted iron came in the form of nails in driftwood or of bands and hoops in wreckage from the ships of unfortunate European navigators. As soon as the era of exploration eastward and westward began at the close of the fifteenth century the wreckage of ships was cast upon the shores of the seven seas. Columbus lost his flagship, the *Santa Maria*, on the coast of Hispaniola in 1492. Magellan lost one of his ships, the *Santiago*, on the southern coast of Patagonia in 1520. Hurtado's ship was captured by the Indians of southern California in 1532. One of Alcazova's vessels was wrecked upon the Brazilian coast in 1537. A Spanish ship belonging to Grijalva's expedition was abandoned on the coast of New Guinea in 1537. One of Mendaña's ships was wrecked on Santa Cruz island in 1595. The *Marigold*, one of Drake's ships, was lost off the Patagonian coast in 1578. In 1587 Cavendish abandoned a small vessel on the coast of Ecuador. The *Santa Margarita*, a Spanish ship, was captured by the natives of one of the Ladrones islands in 1600. Roggewein, in 1722, lost the *African Galley* on an islet near Tahiti. Sherlock's *Speedwell* was wrecked on the island of Juan Fernandez in 1722. In 1741 Anson lost the *Wager* on the southern coast of Chile. These are only a few of the marine casualties that scattered iron among primitive peoples, but they will suffice to suggest how far-flung was the distribution of the useful metal by such means.

The world-wide distribution of iron by accident of wind and wave is a phase of metal usage that the student of cultural distribution must not ignore. The assumption that a piece of iron found, for example, in a prehistoric grave or in a remote part of the world came to the

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indigenes of the particular region by trade with more civilized peoples, such as those of Europe, may prove an error and the source of much profitless speculation.

First Iron From the Sea

A Malay tradition in Perak says that the sword of an ancient king was brought "out of the ocean."[1] A Hawaiian historian records the fact that his people got their first iron from sticks washed up on the land.[2] According to an old Mexican chronicle, an Indian on the northern coast of California in the sixteenth century claimed to have made his knife from an iron spike found in a piece of driftwood.[3] The Chilkat Indians of southeastern Alaska have a tradition that their first piece of iron was found on the shore and that they made a knife of it.

As stated already, Columbus lost the *Santa Maria* off the coast of Hispaniola, the modern Haiti; we can guess what that meant to the natives. Columbus himself tells us that they were eager to obtain pieces of the metal:[4] "They took even the pieces of the broken hoops of the wine barrels and, like savages ["fools" might be a better rendering of "*bestias*"], gave what they had, so that it seemed to me to be wrong and I forbade it." He was greatly mistaken; they were not so foolish as he thought; on the contrary, the pieces of iron they obtained in trade with the Spaniards were much more valuable to them than the things they gave in exchange. Their appreciation of the value of iron, we may presume, argues some previous acquaintance with the metal. It did not antedate the arrival of Columbus and his ships, for it is explicitly stated[5] that there was no metal seen among them "except some small plates of gold which hung at their nostrils." On the same page it is also stated: "Nor had they any knowledge of iron, and therefore they made their javelins . . . . of wands [rods], with the points hardened at the fire, arming them with a fish bone instead of iron." The description of the natives and of their eagerness to obtain iron was written by Columbus when on board ship nearing home. He arrived at Hispaniola on December 6, 1492; he departed on January 16, 1493; the *Santa Maria* was wrecked on December 24, 1492. We may infer, therefore, that after the natives obtained iron from the wreck they became eager to obtain more in exchange for their indigenous commodities.

[1] F. A. Swettenham: On the Native Races of the Straits Settlements and Malay States, *Journ. Anthropol. Inst. of Great Britain and Ireland*, Vol. 16, 1887, pp. 221–229; reference on p. 224.

[2] A. P. Taylor: Sesquicentennial Celebration of Captain Cook's Discovery of Hawaii (1778–1928), *Publ. Archives of Hawaii, No. 4*, Honolulu, 1929, p. 66.

[3] H. R. Wagner: Sir Francis Drake's Voyage Around the World, San Francisco, 1926, p. 497.

[4] Cecil Jane, transl. and edit.: Select Documents Illustrating the Four Voyages of Columbus, Vol. 1, *Hakluyt Soc. Publs.*, Ser. 2, Vol. 65, London, 1930, p. 8.

[5] Ferdinand Columbus: The History of the Life and Actions of Adm. Christopher Columbus . . . . , in Churchill's "A Collection of Voyages and Travels," Vol. 2, London, 1732, pp. 501–628; reference on p. 530.

Driftwood on the Arctic Shores

All the voyagers to the American Arctic, from Greenland to Alaska, and to the adjacent regions in the south, such as the coast of Labrador and the Aleutian Islands, make mention of the driftwood on the shores of these treeless lands. The Aleuts used to be dependent on the drift of the sea for wood to make their spears and huts. Along with the driftwood from the Asiatic shore they doubtless obtained pieces of iron for pointing their weapons. Drift from the Japanese Current making a cyclonic circulation in the Gulf of Alaska was the chief agent bringing such flotsam and jetsam, and during part of the year the westerly winds assisted. A suggestive piece of evidence is the iron bolt that the Russian trader Jacob Chuprov found in the possession of an Aleut in 1745.[6] This probably was obtained from a piece of wreckage. The Russians were actively engaged in shipbuilding at Okhotsk on the Siberian coast in the early eighteenth century.[7]

John Davis, when at Gilbert Sound, on the southwestern coast of Greenland, in 1586, reported that he "saw no wood growing, but found small pieces of wood upon the Islands, & some small pieces of sweete wood among the same."[8] However, he observed much wood floating on the sea. Fotherby, in his account of Baffin's voyage to Spitsbergen in 1613, speaks of the "great store of drift wood, which the sea bestowes on the barren land."[9] The Eskimos of Baffin Bay had knives that Captain Ross concluded were made out of nails found in a piece of wood that had drifted ashore.[10] Alexander Fisher, who was on Parry's ship in 1818, states that on the same coast they picked up "a piece of fir-wood, about 18 inches in length, a good deal waterlogged, but not worm-eaten," in which were found a crooked nail and the rust mark of another.[11] The only ship that had previously been in those waters was Baffin's, in 1616, but Fisher concluded that the piece of wood had floated thither from the south.

Parry, in 1820, when on the west coast of Greenland, found the Eskimos using spears made of narwhal's horn and pointed with pieces of bone, but one old man had a wooden shaft to which was attached "a sharp iron hook, made apparently of a nail."[12] The wood and bone were indigenous; the iron was foreign to their culture and had come to

[6] William Coxe: Account of the Russian Discoveries between Asia and America, 4th edit. (8vo), London, 1803, p. 117.

[7] F. A. Golder: Bering's Voyages, *Amer. Geogr. Soc. Research Ser. No. 1*, New York, 1922, Vol. 1, pp. 30, 32, 34.

[8] Richard Hakluyt: The Principal Navigations, Voiages, Traffiques and Discoveries of the English Nation (3 vols., London, 1598–1600), Vol. 3, 1600, p. 110.

[9] C. R. Markham, edit.: The Voyages of William Baffin, 1612–1622, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 63, London, 1881, p. 58.

[10] John Ross: A Voyage of Discovery . . . for . . . a North-west Passage, London, 1819, p. 95.

[11] New Voyages and Travels, R. Philips & Co., London, Vol. 1, 1819, p. 61.

[12] Alexander Fisher: A Journal of a Voyage of Discovery to the Arctic Regions, 3rd edit., London, 1821, p. 275.

them probably by grace of wind and wave. The Eskimos on Pelly Bay told Rasmussen in 1922 "that all the iron then in use among this tribe, in the form of knives, harpoon-heads, arrow-heads and the like, came from the ship of a white man that had wintered in Felix Harbour and Victoria Harbour a hundred years before." Rasmussen remarks: "This, of course, was Ross."[13] It is interesting to note that the iron implements should have lasted even as long as that. Captain Charles Hall, when on the north shore of Frobisher Bay in 1861, saw

> a ship's beam high and dry on the rocks. It was of oak, 27 feet long and 18 by 12 inches square. Spikes that had once helped to hold fast the ship's deck and the bolts running through at each end were much eaten with rust. It probably belonged to the *Traveller*.[14]

This was an English whaling ship that had been wrecked near Bear Sound three years before. Iron rusts fast in sea water. It is strange that the Eskimos had not availed themselves of these bolts and spikes. Perhaps by that time they easily obtained what iron they needed by trading with the crews on the many ships that were now coming to their country.

The first European to reach the Arctic islands west of Greenland and north of Labrador was Martin Frobisher, in 1576. He found the Eskimos on the island of Meta Incognita, now identified as a part of Baffin Island, already in possession of some iron. "They haue some yron," it is recorded in the description of the voyage,[15] "whereof they make arrow heads, kniues, and other little instruments, to worke their boates, bowes, arrowes, and darts withall." In regard to the probable source of their iron, we are told that it was thought "they haue conuersation with some other people, of whom for exchange they should receiue the same." This would seem to point to the nearest accessible mainland, Labrador, through which, by intertribal trade, it might have been possible to obtain iron from Newfoundland. John Cabot may have reached the Labrador coast in 1498. Gaspar de Cortereal, a Portuguese navigator, visited Greenland in 1500. A year later he set forth on a second voyage, in which he reached southeastern Newfoundland and from which he did not return. The same fate befell his brother Miguel in 1502.[16] If these Portuguese navigators were lost on the coast of Labrador or of Newfoundland, the wreckage of their ships may have provided bits of iron for the savages on those shores. Giovanni da Verrazzano, a Florentine navigator in the French service, in 1524 probably went no farther north than Nova Scotia. Jacques Cartier landed on the coast of Newfoundland in 1534, and shortly

[13] Knud Rasmussen: The Fifth Thule Expedition, 1921–24, *Geogr. Journ.*, Vol. 67, 1926, pp. 123–142; references on pp. 137–138. See also the same: Across Arctic America, New York and London, 1927, pp. 169–170.

[14] C. F. Hall: Life with the Esquimaux, Vol. 2, 1864, p. 176.

[15] Hakluyt, *op. cit.*, Vol. 3, p. 38.

[16] J. P. Howley: The Beothucks or Red Indians, Cambridge, 1915, p. 7.

thereafter the Bretons and the Basques began to frequent the "banks" in the pursuit of the codfish, which gave the island the name of Tierra de Bacalaos. It should be noted that on his first voyage to the land north of Hudson Strait Frobisher lost a boat and five men.

It is improbable, however, that the iron of the Eskimos north of Hudson Strait in the sixteenth century was obtained by intertribal trade from Newfoundland, a distance of a thousand miles. Anything so rare and so extremely useful would be unlikely to pass from hand to hand among savages for so great a distance. It is more probable that these particular Eskimos obtained their first bits of iron from driftwood. The current along the coast of Labrador runs southward, but iron in driftwood might reach Frobisher's Meta Incognita, on the north side of Hudson Strait, by means of the Greenland Current.

George Best, one of the recorders of Frobisher's third voyage, speaking of the Eskimos on Meta Incognita, says:

> They have no wood growing in their Countrey thereabouts, and yet wee find they have some timber among them, which we thinke doth growe farre off to the Southwards of this place, about Canada, or some other part of New found land: for there belike, the trees standing on the cliffes of the sea side, by the waight of yce and snow in Winter overcharging them with waight, when the Sommers thaw commeth above, and also the Sea underfretting them beneath, which winneth dayly of the land, they are undermined and fall downe from those cliffes into the Sea, and with the tydes and currents are driven to and fro upon the coastes further off, and by conjecture are taken up here by these Countrey people, to serve them to planke and strengthen their boates withall, and to make dartes, bowes, and arrowes, and such other things necessarie for their use. And of this kind of drift wood we find all the Seas over great store, which being cut or sawed asunder, by reason of long driving in the Sea is eaten of wormes, and full of holes, of which sort theirs is found to be.[17]

This is a quaint but intelligent piece of observation. However, as the oceanic current from that part of the Arctic region is southward toward Newfoundland, and not the reverse, it is unlikely that the driftwood comes thither from the Canadian coast. In 1577 Frobisher, when sailing northwestward from the Orkney Islands and nearing Iceland, "met with much drift wood, & whole bodies of trees."[18] That evidence is pertinent to the supposition that the wood found upon the coasts of western Greenland and of Baffin Island came thither with the Greenland Current from the North Atlantic and thence from Europe. Some of the driftwood probably came from northern Europe, some of it possibly from Siberia.[19]

Forster infers that iron came into the possession of the Eskimos in Greenland after the destruction of the Norse colony of Eric the Red[20]

[17] Richard Hakluyt: The Principal Navigations, Voyages, Traffiques & Discoveries of the English Nation (Hakluyt Soc. edit., 12 vols., Glasgow, 1903–1905), Vol. 7, 1904, p. 373.

[18] *Idem:* The Principal Navigations, London edit., Vol. 3, p. 61.

[19] Otto Nordenskjöld and Ludwig Mecking: The Geography of the Polar Regions, *Amer. Geogr. Soc. Special Publ. No. 8*, 1928, p. 130.

[20] J. R. Forster: History of the Voyages and Discoveries Made in the North, translated from the German, Dublin, 1786, p. 287.

and that pieces of it have been "hoarded up by them ever since." This suggestion is interesting. It is obvious that as soon as the Norsemen voyaged to Greenland and to the American mainland they would bring iron to these remote parts, not only in trade with the natives, but also inadvertently by wreckage from their ships. On his second expedition, in 985 or 986, Eric the Red lost 11 vessels out of 25, so that driftwood, together with iron nails, bolts, and bands, was scattered along this Arctic coast. As far as recent researches show, the Norse colony perished about the end of the fifteenth century.[21] After that the region was not visited by Europeans until the Elizabethan era, when Martin Frobisher renewed Arctic exploration, his first voyage being in 1576. It is unlikely that iron left by the Norse colonists would have survived so long; the use and wear of it, and the rusting, would cause it to disappear in the course of so long an interval of time. No, the source of the few bits of iron that the Eskimos were found to possess in the sixteenth and seventeenth centuries is more likely to have been driftwood, the wreckage of boats, or hoops of empty barrels washed overboard from European whaling ships in the North Atlantic.

In 1722 Captain Scroggs, of the Hudson's Bay Company, sailed from Fort Churchill in search of Knight's ships. In latitude 62° 48′ "he sent his boat out after a piece of drift-wood, and found it to be a foremast, which had broken off 5 feet above deck."[22] The bands round a mast would furnish good iron to the Eskimos when such a piece of wreckage was washed ashore.

Henry Hudson, in 1610, when on the North American coast in latitude 60° N., which would be near the entrance of Hudson Strait, encountered an Indian "armed with a Mexican or Japonese *cris* (poniard)," meaning a serrated iron knife.[23] Hudson inferred from this that "a place which possessed Mexican arms and productions could not be far distant from that country" and that therefore the strait extended to the Pacific Ocean. The weapon was probably similar to those seen by Ross and Parry in the hands of the Eskimos. In 1611 an Eskimo attacked one of Hudson's crew with a knife, of which Purchas says that it was "a strange kinde of weapon, indented, broad and sharpe, of bright steele, riueted into a handle of *Morse*-tooth."[24] The locality was near Digges Cape, where Hudson Bay connects with Hudson Strait. Christy quotes Purchas as saying that it was a knife "such as they use in Java" and that it was regarded as

[21] Poul Nörlund: Buried Norsemen at Herjolfsnes: An Archæological and Historical Study. *Meddelelser om Grønland*, Vol. 67, 1924, pp. 1–270. (See also William Hovgaard: The Norsemen in Greenland: Recent Discoveries at Herjolfsnes, *Geogr. Rev.*, Vol. 15, 1925, pp. 605–616).

[22] Forster, *op. cit.*, p. 387.

[23] G. M. Asher, edit.: Henry Hudson, the Navigator, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 27, London, 1860, p. 193.

[24] Samuel Purchas: Purchas his Pilgrimage, 4th edit., London, 1626, p. 818.

evidence of the existence of a westward passage to the Orient.[25] The knife was serrated like a Malay kris, and it resembled the knives seen by Parry in possession of the Eskimos on the west coast of Greenland in 1818.[26] Like them, it was fixed in a piece of walrus tooth, but it was broad, and in that respect it was different. However, we need not look to Java or Malaya for its place of origin. The handle and the style were both characteristic of the crude knives made by the Eskimos out of chance pieces of iron.

A "Great Joy" to the Eskimos

Luke Foxe, in 1631, on an island near the north shore of Hudson Bay, found some Eskimo graves in which were darts, "many of them headed with Iron (and nailes), the heads beaten broad wayes. In one of their Darts was a head of Copper, artificially made, wch I tooke to be the work of some Christian."[27] Another Foxe manuscript makes mention of these graves and says that they contained "bows, arrows, and fishing implements, headed with copper, iron, and stone (for want of the two former), which seemeth they have traded with some civil People, or with those that doth trade with them."[28] The supposition that these Eskimos had dealings with some "civil" or "Christian" people, directly or indirectly, by intertribal trade, is not necessary, especially in regard to the copper, which was obtained as native metal in many localities within the bounds of their own extensive habitat. As for the iron, it may have been obtained by the Eskimos from the earlier explorers of Hudson Bay, from which at that time a Northwest Passage was supposed to extend. Besides Hudson himself, the bay had been visited by Button, who lost a ship near Port Nelson on the southwest coast in 1612. Gibbons and Bylot also had been in these parts. On the west coast, in about latitude 61° N., one of Foxe's officers found fragments of a birch canoe and an "Arrowe headed with a nayle, the head beaten broad and put into a shaft of 18 inches long."[29] The nail also may have come from Button's ship. Two ships, the *Albany* and the *Discovery*, of an expedition commanded by James Knight, were wrecked in 1721 near Marble Island, on the west coast of Hudson Bay. The Eskimos said that the last man to die was one who was "always employed in working of iron into implements for them,"[30] these being exchanged for food.

[25] Miller Christy, edit.: The Voyages of Captain Luke Foxe of Hull, and Captain Thomas James of Bristol, in Search of a North-west Passage, in 1631–32 (2 vols.), *Hakluyt Soc. Publs.*, Ser. 1, Vols. 88 and 89, London, 1894, Vol. 1, p. 154, footnote.

[26] New Voyages and Travels, Vol. 1, 1819, p. 57; North-west Passage, Vol. 2, 1831, p. 265. Also Journal of a Voyage to the Arctic Region, by An Officer of the 'Alexander,' no date, p. 61.

[27] Christy, *op. cit.*, Vol. 2, p. 320.

[28] *Ibid.*, p. 320, footnote 3.

[29] *Ibid.*, pp. 332–333.

[30] Samuel Hearne: A Journey from Prince of Wales's Fort in Hudson's Bay, to the Northern Ocean, London, 1795, p. xxxii; new edit., edited by J. B. Tyrrell (Publs. Champlain Soc., No. 6), Toronto, 1911, p. 47.

There is great joy, says Crantz, if the Eskimos "'happen to find a nail in the wood that the sea drives upon their shores.'"[31] John Davis, in 1586, remarked that the Eskimos "are simple in all their conversation, but very theevish in stealing of Iron, of which they make great account."[32] When on the southwest coast of Greenland, he suffered the loss of a boat by reason of the eagerness of the Eskimos to abstract the nails. "The Sauages came to the Island where our pinnace was built readie to bee launched, and tore the two upper strakes, and carried them away onely for the loue of the yron in the boords." When pursued, these Eskimos fled to another island about two miles away, "where they tooke the nayles out of the timber, and left the wood on the Isle."[33]

Forster, in recording Davis's second voyage to the west coast of Greenland in 1586, remarks:

> Iron, being so solid and indestructible a metal, had at all times such a strong attraction for these poor wretches, that they could not possibly resist the great temptation it lay them under of stealing. The Europeans, too, were always so remiss in their care of this article, as to make it very easy for them to commit this theft, and thus provoke the vengeance of these latter.[34]

Iron is not supremely valuable because it is "solid and indestructible," qualities that belong rather to stone; it was in demand by man everywhere because it was tough, strong, and malleable, so that by hammering with stone he could shape it into effective tools and weapons. However, it is not surprising that the Eskimos picked up every piece of iron they found loose on the ship. How many people would refrain from putting their hands on pieces of gold left lying carelessly on a stranger's vessel? The "vengeance" of the Europeans on the poor natives, whenever they removed a nail or a bolt, was indeed unreasonable and proved the cause of much trouble.

One of the seekers for the Northwest Passage in 1746 remarks:

> The People of the Ship bartered their Knives and pieces of Iron Hoop for the Skin-Cloaths, the *Indians* [Eskimos] being willing to dispose of any Thing which they can get an exchange for in Iron, so useful for fixing to the Ends of their Darts; and Harpoons and for many other Purposes, for which otherwise they only use Bone.[35]

Lyon, in 1825, records that six Eskimos on Southampton Island each received a gift of a strong butcher's knife in exchange for some of their crude instruments, which the Englishmen desired to have merely as curiosities.

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[31] David Crantz: The History of Greenland . . . , translated from the High-Dutch, Vol. 1, London, 1767, p. 268.

[32] Christy, *op. cit.*, Vol. 1, p. 67.

[33] Hakluyt, The Principal Navigations, London edit., Vol. 3, p. 112.

[34] Forster, *op. cit.*, p. 307.

[35] An Account of a Voyage for the Discovery of a North-west Passage by Hudson's Streights, to the Western and Southern Ocean of America, Performed in the Year 1746 and 1747, in the Ship *California*, Capt. Francis Smith, Commander, by the clerk of the *California*, Vol. 1, London, 1748, pp. 28–29.

The poor fellows received [them] with silent and trembling delight, first eyeing me, then the knife, and at last uttering a long sighing 'kooyenna' (thank you) in a tone expressive of the deepest gratitude . . .[36]

To say that such a knife was worth more than its weight in gold to these northern savages is to make a childish comparison, because gold was of no value to them. Elsewhere Captain Lyon remarks:

A few instances of dishonesty occurred where iron lay neglected in view; but it is scarcely to be wondered that such a temptation should prove irresistible; had small golden bars been thrown in the streets of London, how would they have fared?[37]

This Arctic explorer informs us of two occasions when a child was offered in exchange for an iron knife.[38] Baffin, in 1616, when on the west coast of Greenland, gave the natives some small pieces of iron, which, he says, "they doe as much esteeme as we Christians do gold and siluer."[39] The most valuable possessions of the Eskimos were their hunting weapons, on which their sustenance depended, and yet, because they could make a better weapon by aid of iron, they were willing to surrender them in exchange. An account of a Danish expedition to Greenland in 1605 says:

They [the Eskimos] manifested . . . a passionate eagerness for every article of steel manufacture, which they were willing to purchase by the sacrifice of their greatest valuables, as of their bows and arrows, their boats and oars. When they had nothing more to offer in exchange, they stripped themselves to the skin, and offered to make away with all the clothes [sealskins] they possessed.[40]

La Peyrère, in describing the Eskimos of Greenland in 1605, says:

They laughed at the gold and silver money which was offered to them, and appeared very eager for any articles made of steel [iron]; for they like them above everything, and would give, in order to obtain them, whatever they most prized, their bows, arrows, boats, and oars; and when they have nothing more to give they stripped themselves and gave their shirts.[41]

Robert Bylot, when exploring the Arctic region near Davis Strait in 1616, recorded a significant incident. In latitude 72° 45′ N. he came "to some islands, where he found nothing but women, whom he treated with kindness, making them presents of iron. To these islands he gave the name of *Women's Isles*."[42] It is a wonder that he did not forthwith dub the women "amazons." The myth of women living by themselves, frequently repeated in the stories of classic and of

[36] G. F. Lyon: A Brief Narrative of an Unsuccessful Attempt to Reach Repulse Bay . . . , London, 1825, p. 57.

[37] *Idem:* The Private Journal of Captain G. F. Lyon, London, 1824, p. 29.

[38] *Ibid.*, pp. 24 and 35.

[39] Markham, *op. cit.*, p. 148.

[40] Hans Egede: A Description of Greenland, translated from the Danish, 2nd edit., London, 1818, p. lxvii.

[41] [Isaac de la Peyrère]: Relation du Groenland [translation], *in* A Collection of Documents on Spitzbergen & Greenland, edited by Adam White, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 18, London, 1855, pp. 175–249; reference on p. 219.

[42] Forster, *op. cit.*, p. 352.

medieval exploration, arose probably from the same cause, namely the absence of the men on a hunting expedition. In this case the Arctic explorer treated the women "with kindness," and we note that his idea of courtesy was to give them, not beads or other bits of jewelry, much less powder puffs, but bits of iron. He was a considerate benefactor; we can readily imagine how pleased their men must have been, when they returned from the seal hunt, to find such valuable gifts.

Arthur Barlowe, in 1584, reports that the Indians at a certain place on the coast of Virginia had a few iron implements, which they had obtained twenty years before. These, he was told, came "out of a wracke which happened upon their coast of some Christian shippe . . . out of whose sides they drewe the nailes and spikes, and with those they made their best instruments."[43] Verrazzano states that the Indians on the island generally identified as Martha's Vineyard, although making use of native copper, did not care for "thinges made of steele and Iron,"[44] which suggests that they were not acquainted with iron, even in driftwood, presumably because the direction of the oceanic currents was not favorable.

It is related that, when the Spaniards landed on one of the Canary Islands in 1382 and showed pieces of iron to the natives, they were eager to have it, because "they found it exceeding every thing in strength, therefore they called it *Esero*," which in their language meant "strong."[45] This argues a previous acquaintance with iron.

Drift Iron in the South Seas

On some of the islands in the South Seas, when they were first visited by European navigators, the natives were unwilling to trade their fruits and other foodstuffs for pieces of iron, simply because they had never seen any before and therefore did not know its use. That happened when Captain Cook landed on the island of Tanna, one of the Hebrides group, in 1774.[46] Likewise, when Captain Cook first visited New Zealand in 1769, the Maoris were ignorant of iron and would not take it in exchange. According to Banks, "neither the inhabitants of this place, or any other part of the coast that we have seen know the use of iron, or set the least value upon it, preferring the most worthless and useless trifle, not only to a nail but to any tool of that metal."[47] But when once they had discovered the supreme use-

[43] Richard Hakluyt: The Principall Navigations, 1589, p. 730.

[44] Richard Hakluyt: Divers Voyages Touching the Discovery of America and the Islands Adjacent, Collected and Published by Richard Hakluyt . . . in the Year 1582, edited by J. W. Jones, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 7, London, 1850, p. 66.

[45] George Glas, transl.: The History of the Discovery and Conquest of the Canary Islands, *in* A General Collection of . . . Voyages and Travels . . . , by John Pinkerton, Vol. 16, London, 1814, pp. 808–826; reference on p. 814.

[46] John H. Moore: Voyages and Travels, Vol. 2, 1778, p. 1146.

[47] John Hawkesworth: An Account of the Voyages . . . , Vol. 2, London, 1773, p. 348. Also Journal of Sir Joseph Banks, edited by Sir Joseph Hooker, 1896, p. 184.

fulness of iron, they were glad to get it. When Captain Cook revisited New Zealand in 1773, the natives coveted nails. "These people," he says, "were extravagantly fond of nails above every other thing."[48] The Maoris now were so eager to possess a piece of iron that they did as the Tahitians and the Hawaiians had done—"offering their daughters and sisters promiscuously to every person's embrace in exchange for our iron tools, which they knew could not be purchased at an easier rate."[49] "Their love of Iron (Nails) is so great that the women (or rather Girls, for they were very young & small) prostitute themselves to any of our People for a Nail, hardly looking upon Knives, Beads, or any toy,"[50] is the testimony of Henry Ibbot, a young midshipman with Captain Wallis on the *Dolphin*, when at Tahiti in 1767. The Tahitians had learned to use iron before Wallis discovered the islands;[51] they desired nails, rather than iron tools of European manufacture, because they hammered the nails into the shape of *toës*, or adze blades, for hollowing a log to make a canoe; furthermore, iron spikes were of great service to the islanders in perforating the planks with which they attached the washboards for enlarging the hull.

On the coast of Brazil, says Pigafetta, when recording Magellan's circumnavigation, "the men gave us one or two of their young daughters as slaves for one hatchet or one large knife, but they would not give us their wives in exchange for anything at all."[52] That indicates at least one step above unmitigated savagery. Paul Clain, a Jesuit missionary, writing in 1697, speaks of the eagerness with which the natives of the Caroline Islands received presents of iron.

> The Father Missionary having given each of them a pretty thick Piece of Iron, they discovered more Joy at receiving this Present, than if it had been so much Gold; and were so fearful of its being stole, that they laid it under their Heads whenever they went to sleep. Their only Weapons are Lances, or Arrows made of human Bones.[53]

Mendaña's crew found a tool made of an iron nail on a coral reef, probably one of the Marshall group.[54] That was in 1567, and the island was in latitude 5° N. This nail could not have come thither in the course of trade, for no European ship had called at this island before. On the other hand, several vessels had been wrecked on islands not far away. Saavedra lost two ships in 1527 when on his way from Mexico to the Ladrones, and a year before Loaysa had lost

[48] James Cook: A Voyage Towards the South Pole, and Round the World, 2nd edit., Vol. 1, London, 1777, p. 234.

[49] George Forster: A Voyage Round the World, Vol. 1, London, 1777, p. 212.

[50] B. G. Corney, transl. and edit.: The Quest and Occupation of Tahiti . . . , Vol. 2, *Hakluyt Soc. Publs.*, Ser. 2, Vol. 36, London, 1915, p. 460.

[51] T. A. Rickard: The Knowledge and Use of Iron Among the South Sea Islanders, *Journ. Royal Anthropol. Inst.*, Vol. 62, 1932, pp. 1–22.

[52] Antonio Pigafetta: Magellan's Voyage Around the World, translated and edited by J. A. Robertson, Vol. 1, Cleveland, 1906, p. 43.

[53] John Lockman: Travels of the Jesuits, Vol. 1, London, 1743, p. 34.

[54] James Burney: A Chronological History of the Discoveries in the South Sea or Pacific Ocean, Part 1, London, 1803, p. 285.

a ship on Sangi, south of the Philippines. The stories of exploration by European navigators during the sixteenth and seventeenth centuries are punctuated with losses of ships, wrecked upon uncharted shores, from which the wind and wave would carry bits of driftwood enriched by iron to the remote parts of the oceans.

Captain Cook found the Hawaiians on the island of Kauai in possession of two pieces of iron; one was part of a hoop, which had been fitted into a wooden handle; the other was thought to be the point of a broadsword. This seemed, at first, to suggest that he and his men were not the first Europeans to visit the island, but Cook concluded that such an idea was negatived by the surprise shown by the natives at sight of the ships and also by their evident ignorance of firearms.[55] Although Cook's ships were the first to come to the Hawaiian Islands, the natives had traditions of small boats that had sought shelter on their shores. It must be remembered that in the sixteenth century the Spanish navigators had great difficulty in making the return voyage from the Philippine Islands to Mexico, owing to contrary winds. A number of the Manila galleons were lost in the years 1575 to 1602 in the hazardous voyage to Acapulco. Some of their wreckage might well have reached the Hawaiian Islands. In the museum at Honolulu there is an old relic in the shape of a worm-eaten piece of wood from which protrudes a large bolt, which was found on the beach of a small island near Kauai.[56] Cook mentions the fact that one of his people saw in one of the houses some wood that "he judged to be fir" and that had been washed ashore, probably from the northwestern coast of the American mainland; and he remarks that "it cannot be thought at all extraordinary, that part of such wrecks [of Spanish ships], containing iron, should, by the Easterly trade wind, be, from time to time, cast upon islands scattered about this vast ocean."[57]

Kotzebue, the Russian navigator, tells us that at Otdia, one of the Radack (or Marshall) group of coral reefs, in 1817, the islanders were using driftwood for lack of better timber when constructing their canoes.

> The sea throws up on the reefs of Radack the trunks of northern firs and trees of the torrid zone (palms, bamboo). It provides the inhabitants, not only with timber for boats, but it also brings them, in the wrecks of European ships, the iron which they want. We did not find among them any tools to work their wood, except the valuable metal obtained in this manner; and when we would not credit the assertion of our friends [the natives] in this respect, we found ourselves such a piece of wood, with nails remaining in it on the shore, under the lee of one of the islands of the group of Otdia. They receive, in a similar manner, another treasure, hard stones fit for whetting. They are sought for in the roots and hollows of the trees which the sea

[55] James Cook: A Voyage to the Pacific Ocean, Vol. 2, London, 1784, p. 240. E. W. Dahlgren, Were the Hawaiian Islands Visited by the Spaniards Before Their Discovery by Captain Cook in 1778? *Kungl. Svenska Vetenskapsakademiens Handlingar*, Vol. 57, No. 4, Stockholm, 1916, p. 149.

[56] H. B. Restarick: The Discovery of Hawaii, 1930, p. 26.

[57] James Cook, A Voyage to the Pacific Ocean, Vol. 2, p. 243.

throws up: iron and stones belong to the chiefs, to whom they must be delivered, on payment of a reward; punishment being inflicted, in case of concealment.[58]

This is most interesting. On these islands no stones except pieces of crumbly coral are obtainable; therefore the stones brought entangled in the tree roots were as valuable as the iron, because without the aid of a hard stone the iron could not be made serviceable. The mention of firs is significant, because this points to the northwestern coast of America, probably California and Oregon, as the source of the wood. The Marshall Islands lie about ten degrees north of the equator and ten degrees south of the Hawaiian Islands. Trees from the American coast are known to drift to Hawaii, and it is not strange that some of them should be carried southwestward to the coral reefs visited by Kotzebue. He also describes how one of his officers actually found the islanders constructing a canoe by aid of an adze made out of a piece of iron four inches long and two inches broad.[59] The natives explained that their tool had been made from an iron band on a large wooden beam, probably part of a mast that had floated ashore from the northeast.

The disappearance of the La Pérouse scientific expedition was long one of the mysteries of the sea. The *Astrolabe* and *Boussole* were last seen at Botany Bay in 1788. In 1827 Dillon found what must have been wreckage from these ships on Vanikoro (Mannicolo) Island, one of the Santa Cruz group, north of the New Hebrides.

While Martin Bushart was on shore he visited one of the houses, from whence he procured in exchange four iron adzes of native manufacture. The natives said that they procured the material for making them from the ships wrecked off Paiow and Wannow. Indeed there appeared to be no scarcity of this metal on shore, as the people in the boats observed that every man had a small adze of native manufacture.[60]

Dillon also (p. 124) refers to "pieces of flat iron beaten out with stones in a rude form by the islanders, into the shapes of coarse carpenter's tools." These were named *tokees* and were like the *toës* of the Tahitians. The natives came from adjacent islands to exchange bolts and other bits of iron taken from the wrecks for serviceable tools, such as the hatchets offered by Dillon and his officers.

In 1821 two English missionaries, when at Huahine, one of the Tahiti group of islands, heard some of the stories of the first use of iron by the natives.

We have been told that the first nail ever seen in this island was taken from a boat at Raiatea. It was a spike-nail, and brought hither by its fortunate possessor as something of rare value. And so it proved, for he made no small gain by lending it out for hire, to canoe-builders, to bore holes in the sides of their planks. After-

[58] Otto von Kotzebue: A Voyage of Discovery, into the South Sea and Beering's Straits . . . , translated by H. E. Lloyd (3 vols., London, 1821), Vol. 3, pp. 154–155.

[59] *Ibid.*, Vol. 2, p. 63.

[60] P. Dillon: Narrative and Successful Result of a Voyage in the South Seas . . . to Ascertain the Actual Fate of La Pérouse's Expedition, Vol. 2, London, 1829, pp. 146–147.

wards, another lucky fellow got hold of a nail, and not knowing how such a thing came into existence, he shrewdly conjectured that it must have been formed by a process of vegetation. Wherefore, to propagate so valuable an exotic, he planted his nail in the ground, but waited in vain for the blade, the bud, the blossom, and the fruit.[61]

The hiring of nails to canoe builders is reminiscent of the Tahitian chief that, Cook tells us, obtained two nails and "received no small emolument" by lending them to his neighbours. Cook also quotes Cantova as saying that the chiefs of the Caroline Islands appropriate for themselves any iron that may come to the islands and make implements that are loaned at a price—and *ce louage se paye assez cher.*[62] The ignorance of the nature of metals and the attempt to make them grow are recorded also by Ellis, who says that to the Tahitians they seemed to be like the shoots of the breadfruit tree.[63]

How iron could be conveyed from one group of islands in the Pacific to another by means of storm-driven canoes is illustrated in the story, told by Kotzebue, of four natives of the Caroline Islands that drifted in their canoe for 1500 miles to one of the Radack group. They were carried ashore insensible.

A Tamon [chief] was present at the moment; the iron utensils which the unfortunate men still possessed dazzled their deliverers, and they were on the point of striking the fatal blow, to divide their spoil, when Tigedien, the Tamon of the island of Aur, fortunately came in time to save their lives.[64]

The Andamanese, an extremely backward people, obtained iron before the end of the eighteenth century from the numerous wrecks[65] on their shores. John Ritchie visited the islands in 1791. He says that two natives came to the ship in a canoe. He gave them some nails and bits of old iron, which pleased them very much and made them greedy for more, whereupon they tried to pull the chain plates from the vessel's side and even attempted to drag away the rudder chains; these being too firmly fixed, they left the ship and paddled to the shore, looking at the nails rapturously and singing all the way.[66] Marco Polo says that the ships of India, in 1278, were "double-planked." "These are caulked with oakum both inside and without, and are fastened with iron nails."[67] The wreckage of such ships would rejoice the Andamanese, if haply it still contained nails. Polo, when speaking of the natives on the islands named Najabalus, says that they came off in their canoes and trucked ambergris and coconuts for pieces of

[61] Daniel Tyerman and George Bennet: Journal of Voyages and Travels . . . , compiled . . . by James Montgomery, Vol. 1, Boston, 1832, pp. 182–183.

[62] James Cook: A Voyage to the Pacific Ocean, Vol. 2, p. 242 and footnote.

[63] William Ellis: Polynesian Researches, Vol. 1, 1833, p. 125.

[64] Kotzebue, *op. cit.*, Vol. 2, p. 123.

[65] A. R. Brown: The Andaman Islanders, Cambridge, 1922, p. 444.

[66] *Indian Antiquary*, Vol. 30, 1901, p. 232.

[67] Manuel Komroff, edit.: The Travels of Marco Polo, New York, 1926, p. 262.

iron, just as the South Sea Islanders did when visited by the English navigators five hundred years later.[68]

The Hunger for Iron

Thus we see that the proverbial greed for gold, the *auri sacra fames* of Virgil, is duplicated in the hunger for iron, which, to a primitive people suddenly brought into touch with the manufactures of modern Europe, was positively precious. The aborigines sometimes, however, were sadly fooled by their love of iron. Herrera tells the story of Ojeda's treachery to the Indian chief Caunabo, on the island of Hispaniola, whom he beguiled into consenting to be fitted with iron fetters and handcuffs that were so polished as to look like silver, whereupon Caunabo was made prisoner, to die later on a Spanish ship that never reached port.[69] In the records of the first voyage around the world it is related by Pigafetta that when Magellan had caused shackles of iron to be placed on the legs of two Patagonians they showed keen pleasure at the sight of "the bright and shining metal," but, shortly discovering themselves bound helplessly, they "raged like bulls"[70] in their disgust and terror.

The Patagonians, by contact with the Spaniards coming southward from Chile, learned the use of iron. Later they obtained pieces of iron from wreckage. Byron says that a cacique, or chief, having heard of the wreck of the *Wager*, one of Anson's ships, in 1741, upon an island near the Strait of Magellan, set out to gather such iron as was obtainable: "for that metal," remarks Byron, "is become very valuable to those savages, since their commerce with the Spaniards has taught them to apply it to several purposes." This Patagonian chief, aware that the secreting of anything, "even an old rusty nail," from the Spaniards was dangerous, was careful to conceal the material he gathered from the wreck until he could carry it away.[71] At that time the Spaniards had to bring their own iron from Spain to South America, and the metal therefore was scarce and expensive.

Fabrication of Iron by Savages

Sometimes when savages first obtain tools of iron they have so little idea of the essential qualities of the metal that they use the tools as if they were stone implements. Rawling says that he saw a Tapiro native of New Guinea "trying to break a stone with a good butcher's knife" that he had just earned as payment for much hard labor; "it was quite a common sight to see a carving knife so chipped as to be

[68] Sir Henry Yule, transl. and edit.: The Book of Ser Marco Polo . . . , 3rd edit., revised . . . by Henri Cordier, Vol. 2, London, 1903, p. 308.

[69] Robert Kerr: Voyages and Travels, Vol. 3, 1824, p. 332.

[70] Pigafetta, *op. cit.*, p. 57.

[71] John Byron: The Narrative of the Honourable John Byron, London, 1768, pp. 104–105.

nearly useless even on the first day it had come into the possession of its owner."[72] Lieutenant Watts, at Otaheite in 1788, says:

It already has been observed that no ship of any nation had visited this island since Captain Cook [in 1777], and from appearances, the iron which the natives obtained at that time was pretty well exhausted, as the only iron now seen was the blade of a table-knife; neither did they bring any tools on board to be sharpened, which certainly would have been the case had they been possessed of any, and such was their avidity to obtain hatchets, knives, &c. that every produce the island afforded was purchased at very reasonable rates.[73]

In one of the Icelandic sagas—that of Thorfinn Karlsefni—there is a description of the manner in which the Eskimos, whom the Norsemen named Skrælings, used iron when first they obtained some of it.

The Skrælings found also a dead man [after a fight with the Norsemen], and an axe lay by him; one of them took up the axe, and cut wood with it, and now one after another did the same, and thought it was an excellent thing, and bit well; after that one took it, and cut at a stone, so that the axe broke, and then thought they it was of no use, because it would not cut stone, and they threw it away.[74]

As a rule, however, primitive man appears to have been quick to appreciate the true qualities of iron, which are toughness and malleability. Captain Wallis remarks that the South Sea Islanders "the moment they got a piece of iron in their possession, began to sharpen it, but made no such attempt on brass or copper."[75] The Russian navigator, Captain Krusenstern, when at one of the Marquesas Islands in 1803, remarked concerning the natives that "the smallest piece of iron that they received from us, they instantly fastened to a handle, after sharpening the edge of it."[76] Captain Lyon, when in the Arctic regions, found the Eskimos in possession of an adze whose blade was the iron of an English hatchet. It had been attached to a short handle, probably of bone, by means of strong sealskin thongs. The haft was scooped in such a way as to fit the hand, each finger having its own place.[77]

Portlock, when trading for furs, lost an anchor on the Alaskan coast, near Yakutat, in 1787, the natives having contrived to cut the cable. Two years later one of the natives informed the Russian trader Izmailov of the theft, whereupon he sent men to recover the anchor. They found that the natives had removed the flukes and the ring. The anchor weighed 780 pounds.[78]

[72] C. G. Rawling: The Land of the New Guinea Pygmies, London, 1913, pp. 178–179.

[73] John Stockdale: The Voyage of Governor Phillip to Botany Bay, London, 1789, pp. 237–238.

[74] N. L. Beamish: The Discovery of America by the Northmen, in the Tenth Century, London, 1841, p. 99.

[75] Samuel Wallis: An Account of a Voyage Round the World . . . , *in* An Account of the Voyages . . . for Making Discoveries in the Southern Hemisphere, by John Hawkesworth, Vol. 1, London, 1773, pp. 141–302; reference on p. 276.

[76] A. J. von Krusenstern: Voyage Rourd the World . . . , translated from the original German by R. B. Hoppner, Vol. 1, London, 1813, p. 162.

[77] Lyon, The Private Journal, p. 38.

[78] Coxe, *op. cit.*, p. 340.

Meares, in 1788, refers to the quickness with which the Indians at Nootka, on Vancouver Island, acquired enough skill to make an iron tool.

> They contrived to forge from the iron they procured of us, a kind of tool, which answered the purpose of hollowing out large trees much better than any utensil we could give them. This business they accomplished by main strength, with a flat stone by way of anvil, and a round one which served the purpose of an hammer; and with these instruments they shaped the iron from the fire into a tool bearing some resemblance to a cooper's adze, which they fastened to an handle of wood with cords made of sinews; and being sharpened at the end, was extremely well adapted to the uses for which it was intended.[79]

By that time they had had many chances of seeing the English blacksmiths at work. The tool they made was similar in shape to their earlier adzes of bone and shell. Primitive man usually preferred the adze to the hatchet as a working tool.

It is interesting to note the fact that these savages had little difficulty in discovering how they could shape the European iron that first came to them in driftwood or by barter. Their stone hammers sufficed for the purpose, because the metal was wrought iron and therefore malleable. They worked it in the cold, by hammering and grinding; it was usually a long time before they learned to forge it. For that reason they had difficulty in repairing the iron implements they obtained from the traders. In the seventeenth century the Eskimos of southern Labrador obtained pieces of iron from the codfishers, many of them Basques from La Bayonne and St. Jean de Luz. In the "Jesuit Relations" it is written: "The iron which they find near the stages of the cod-fishers serves them to make arrow-heads, knives, cleavers, and other tools, which they themselves skillfully devise, without forge or hammers."[80] That is to say, they did it without the use of fire or of iron hammers; they used stone hammers on stone anvils.

Alexander Selkirk, the prototype of Robinson Crusoe, when a castaway upon the island of Juan Fernandez in the early eighteenth century, made good use of the iron that he found on casks washed ashore. "When his Knife was wore to the back, he made others as well as he could of some Iron Hoops that were left ashore, which he beat thin and ground upon Stones."[81] An intelligent savage, such as a Tahitian, would have done the same.

Another, and earlier, castaway on the same island of Juan Fernandez was a Mosquito Indian from Honduras, left there by Dampier in 1681. He remained alone for three years, until rescued by Dampier, who tells us how he made weapons and tools. When he landed he had

[79] John Meares: Voyages . . . from China to the North West Coast of America, London, 1790, pp. 262–263.

[80] R. G. Thwaites, edit.: The Jesuit Relations and Allied Documents, Vol. 45, Cleveland, 1899, p. 69.

[81] Woodes Rogers: A Cruising Voyage Round the World, 2nd edit., London, 1718, p. 128.

a musket and a knife, and it must be remembered that he was not an unsophisticated savage but had lived all his life among Europeans.

> He contrived a way by notching his Knife, to saw the Barrel of his Gun into small Pieces, wherewith he made Harpoons, Lances, Hooks and a long Knife; heating the pieces first in the fire, which he struck with his Gun-flint, and a piece of the Barrel of his Gun, which he hardened; having learnt to do that among the English. The hot pieces of Iron he would hammer out and bend as he pleased with Stones, and saw them with his jagged Knife, or grind them to an edge by long labour, and harden them to a good temper as there was occasion. All this may seem strange to those that are not acquainted with the sagacity of the Indians; but it is no more than these Moskito Men are accustomed to in their own Country, where they make their own Fishing and Striking Instruments, without either Forge or Anvil; tho' they spend a great deal of time about them.[82]

In the record of four Russians who, in 1743, were marooned for six years on the island of East Spitsbergen, we are told

> nothing proved of more essential service to these unfortunate men, during the first year of their exile, than some boards they found upon the beach, having a long iron hook, some nails about five or six inches long, and proportionately thick, and other bits of old iron found in them, the melancholy relics of some vessel cast away in those remote parts.[83]

Theft of Iron

Many of the savages with whom the Europeans first came in contact obtained iron in various forms when they killed the invaders from overseas and took their boats. It will be recalled that Captain Cook lost his life in a dispute with the Hawaiians that was started by their theft of a boat for the sake of extracting the nails and other ironwork. Meares complains in 1788 that his pinnace was stolen by the Indians on the coast of British Columbia. It "had been stolen and broken up for the sake of the iron and nails."[84] Similar incidents are recorded by sundry navigators; for example, by Dillon, at Tucopia, one of the Friendly Islands.[85] The first European to reach the American mainland from Kamchatka, the Russian navigator Chirikov, lost two boats on the Alaskan coast, near Sitka, in 1741. The crews probably were massacred and eaten. The iron implements of the unfortunate Russians and the ironwork of their boats were valuable to these savages and represented a magnificent acquisition of useful metal. In 1763 the crew of a Russian vessel commanded by Dusinin was attacked by the Aleuts of Unalaska; the vessel was captured, and most of the Russians were killed. It is recorded that the islanders took all the ironwork but left some leather sacks of provisions.[86] When Glottov, in 1764, landed on Umnak, one of the Aleutian Islands, he

[82] William Dampier: Dampier's Voyages, edited by John Masefield, Vol. 1, London, 1906, pp. 112–113.

[83] J. von Straelin: An Account of the New Archipelago, translated from the German, 1774, p. 61.

[84] Meares, *op. cit.*, p. 128.

[85] Dillon, *op. cit.*, p. 115. See also the *Hawaiian Spectator*, Vol. 2, 1839, p. 71.

[86] Coxe, *op. cit.*, p. 165.

found "the remains of a burnt vessel, some prayer-books, images [icons], &c.; but all the iron-work and cordage were carried off."[87] To the islanders the burning of the vessel presented a convenient method of separating the iron from the wood. Later, in 1765, when Koronov was attacked on Umnak Island, it is recorded that the natives "returned in a considerable body, armed with lances, made from the iron of the plundered vessels."[88] These savages had seized and looted three Russian ships in the course of three years.

A Warning

These instances of the accidental distribution of a material of profound importance in cultural development carry a warning, as was observed at the beginning of this paper. As a further caution against hasty conclusions, I may cite the stranded whale with an iron harpoon stuck in its side that was found in 1716 on the western coast of Kamchatka by Henry Bush, a Hollander.[89] On the harpoon was some Roman, that is to say European, lettering. Hendrik Hamel, whose narrative was published at Rotterdam in 1668,[90] reports a whale with an iron harpoon in its side on the shore of Korea in 1653. Reference to these statements is made by De Peyster, who quotes Hamel further as saying that

> every year in the sea to the North-East of Korea, whales in great numbers are captured, in whose flesh and blubber are found harpoons, and other striking irons of the French and Dutch whalers, in the seas washing the Northern extremities of Europe.[91]

These facts are quoted by De Peyster to prove that a northeast passage, around northern Russia and northern Siberia, from western Europe to China, was available to whales, if not to ships. He adds that a whale struck by William Bastiaanz, a Dutch admiral, "in the Spitzbergen sea, was killed in the sea of Tartary," where the whale was found with the admiral's harpoon, bearing his initials, and other marks of recognition, still sticking in its back. The distance of this whale's travels must have been at least 5000 miles. The cruising capacity of a whale is such as to render possible the carriage of an iron harpoon from China to Peru. And what if a piece of iron, obtained through such a source, had been unearthed among the relics of the Incas? It would have been even more perplexing than the Elizabethan sixpence that was found, thanks to rodents, in a neolithic cromlech.

[87] *Ibid.*, p. 197.

[88] *Ibid.*, pp. 220–221.

[89] [G. F.] Müller: Voyages from Asia to America . . . , translated from the High Dutch of S. [*sic*] Muller; With the Addition of Three New Maps . . . , by Thomas Jefferys, London, 1761, p. xlii.

[90] James Burney, A Chronological History of North-eastern Voyages of Discovery, London, 1819, pp. 109 and 110.

[91] J. W. de Peyster: The Dutch at the North Pole . . . , New York Historical Society, New York, 1857, p. 10.

THE EARLY CASTING OF IRON

A STAGE IN IRON AGE CIVILIZATION

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DESPITE the large amount of work that has been done on the history of iron and the important way in which that metal is interrelated with archeological studies, in both the geographical and the historical fields, very little scholarly research has been directed towards the discovery of the casting of iron and its implications. Archeologists and geographers are generally unfamiliar with the technical processes involved, while conversely mineral technologists are unfamiliar with the geographical and cultural aspects.

Two recent writers in the metallurgical field have supported the erroneous belief, widely held, that iron was not cast before the Middle Ages. J. Newton Friend concludes his "Iron in Antiquity"[1] with "a brief note on the discovery of cast iron," which he ascribes to accident in the operation of the German *stückofen* in the Middle Ages. But museums have many specimens of cast iron that antedate medieval times by more than a thousand years. T. A. Rickard in his "Man and Metals" says: "The making of cannon, and more particularly the making of cannon-balls, was the chief incentive to the invention of cast-iron."[2] The need for a cheap metal from which to cast cannon balls and cannon did indeed furnish a new use for cast iron, while the *stückofen* made it cheap. But cast iron had been used for other purposes more than a thousand years before.

The Metallurgy of Iron

For the benefit of readers unfamiliar with the metallurgy of iron a few words of explanation are necessary. As everyone knows, oxides of iron are widely distributed minerals, occurring in deposits that often contain millions of tons. If iron oxide is heated to a rather low temperature (a dull red heat) in the presence of an *excess* of carbon (if more than a limited amount of carbon dioxide is present, either the reduction will not take place or the iron will go back to oxide), the oxide is reduced to metal. The product of such an operation is soft, pure iron that cannot be melted in a small furnace, since its melting point is 1530° C. But if the iron is held at a high heat for some time in contact with carbon, it absorbs the carbon, much as a blotter absorbs ink. (The metallurgical mechanism of carbon absorption is complicated, but the analogy will serve our purposes here.) With

[1] Iron in Antiquity, London, 1926.
[2] Man and Metals, 2 vols., New York and London, 1932; reference in Vol. 2, p. 887.

increase of carbon content the melting point of iron is lowered, reaching a minimum of 1170° C., when the carbon content is 86 pounds to a ton of iron. Such a metal is the hard, brittle substance known as cast iron. As soon as the carbon content exceeds five or ten pounds to the ton of iron, the metal, though still soft and malleable when allowed to cool slowly, shows a marked increase in hardness if plunged into cold water or oil and is then known as steel. Modern steel is made by reducing the iron ore in a tall furnace to a metal, pig iron, containing 70 to 100 pounds of carbon a ton. The carbon is removed in a furnace hot enough to keep the pig iron melted, the desired amount of carbon is added (except for tool steel, less than 20 pounds a ton), the steel is cast into ingots and is finally rolled.

Apparently the soft, pure iron[3] that was the normal product of the primitive furnace was forged into the desired form and then caused to absorb carbon by being heated in charcoal—a process similar to the modern casehardening. This leaves the core soft and tough (carbon-free), while the outer surface takes up enough carbon so that it can be hardened by being plunged, while red-hot, into water. To learn how to control the carbon content must have taken centuries of empirical experiment. The phenomenon was not understood; the primitive smiths merely knew that if they conducted the operation in the right way they sometimes obtained good metal. Raw materials and results were variable, and it is truly remarkable that the smiths were able to make any good metal. Good-quality iron was expensive, probably much more expensive than bronze, which is much easier for a worker to handle who does not understand the "why" of the operation.

Early Iron Casting in Europe

It is unquestioned fact that very little cast iron appeared in Europe and Western Asia before the Middle Ages, though metal workers there had been casting in bronze for at least three thousand years. The error of supposing that no cast iron was produced in that part of the world before that time seems to be traceable to German commentators on Pausanias of half a century ago. Pausanias speaks of:[4] "Theodorus the Samian [sixth century before Christ] who invented how to pour (*diacheai*) iron and to fabricate statues from it." H. Blümner, who wrote the article on iron in Pauly-Wissowa and, with Hitzig, edited the text of Pausanias, says of the Greeks, "Eisen lasse sich nicht giessen." It seems to have been the fashion in Germany at that time to believe that Pausanias made many errors, but later research has vindicated his general accuracy.

The evidence available to Blümner may be summarized by saying

[3] It is quite possible that smiths often left the iron in the reduction furnace long enough to absorb sufficient carbon so that it would harden when quenched after being forged into shape.

[4] *Description of Greece*, III. 12:10.

that Aristotle,[5] writing two centuries before Pausanias, was obviously familiar with the melting of iron. Pausanias speaks (IV, 31:10) of an iron statute of Epameinondas and (X, 24:5) of the iron throne of Pindar, of a statue of Hercules by one Tisagoras, a head of a lion, and a wild boar of iron (X, 18:6), and incidentally remarks: "The working of iron into statues happens to be the most difficult, and a matter of the greatest labor. The work of Tisagoras (whoever he was) is therefore wonderful." Pliny, who wrote about two centuries after Pausanias, says "ferreus Hercules, quem fecit Alcon,"[6] and, since this is found at the end of a chapter on casting bronze statues, most translators have assumed he meant a cast-iron statue. But Pliny's statement (XXXIV, 41:146) "mirumque cum excoquatur vena aquae modo liquari ferrum, postea in spongeas frangi" has puzzled translators. I believe that light is thrown on it by XXXIII, 30:94, where he says that pine logs make the best fire for melting copper and iron; here he uses the verb *fundo*, whereas when he talks of the reduction of iron from iron oxide (XXXIV, 41:142 and 146) he uses the verb *excoquo*. Pliny was obviously not personally familiar with iron metallurgy and did not clearly explain (what perhaps he did not clearly understand) that in making an unfused lump of iron from ore some fused metal was sometimes produced. But there seems no reason, from what Pliny says, for doubting that the Romans could and sometimes did melt iron.

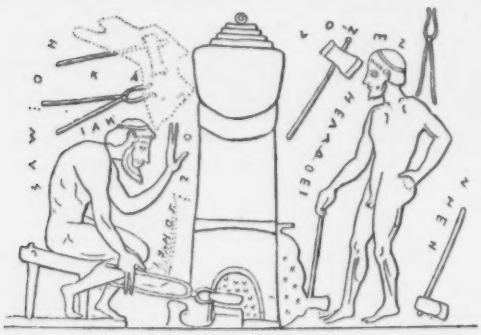

FIG. 1—Iron furnace as shown on an old Greek vase. Though here being used to produce a bloom of unfused metal, iron could be melted in such a furnace.

The drawing of an iron furnace that appears on an old Greek vase, shown in Figure 1, is similar to several others still available to us. Any open-minded metallurgist would agree that this furnace represents a contrivance in which fused iron could be made, if desired, and would hazard the opinion that in using it to produce "blooms" of unfused iron the operatives would occasionally produce some fused metal, even though they did not wish to do so. There are also a few pieces of cast iron known that are ascribed to Greek and Roman times. With this evidence before him Blümner stubbornly maintained that neither the Greeks nor the Romans could melt iron, though his reasoning is hard to follow. But such was his prestige that later writers generally accepted his conclusions.

[5] *Meteorologica*, IV, 6.
[6] *Historiae naturalis*, XXXIV, 40:141.

Early Iron Casting in China

Before discussing why the Greeks and Romans seldom used cast iron we must turn to the casting of iron in China. For that region we have the irrefutable evidence of cast-iron objects still in existence. The largest, a cast-iron lion about 20 feet high and 18 feet long, which stands near the Tientsin-Pukow railway at Tsangchow, is probably the largest cast-iron statue ever made. Arthur W. Hummel, of the Library of Congress, has kindly translated the following excerpt from the local history, printed in 1603, and he adds that the date 954 A.D., when Shih-tsung conquered the Kitans "can be taken with reasonable certainty as the exact year the statue was cast."

> When [Emperor] Shih-tsung waged war against the Kitans and was encamped in ancient Tsang (chow) there was a man who, though guilty of a criminal offense, was skilled in casting metals. He cast a lion to stand guard over the city, and (by so doing) gained remission of his crime. It is 17 [Chinese] feet high and 16 feet long. One night the local people snatched the tail and [part of] the belly, and to this day these parts are missing.

At Pingtingchow, Shansi, there is a large cast-iron bell, which is dated 1079 A.D. At Chin-ssu, 10 miles southwest of Taiyuanfu, Shansi, there is an iron statue, larger than life-size, which is dated by the inscription on it as having been cast in the year 1097 A.D. Four similar statues at a temple at Tengfênghsien, Honan, are definitely dated 1213 A.D. In the "Thousand Buddha Hall" of the Hsuan-chung-ssu, about thirty miles southwest of Taiyuanfu, there were in 1920 225 cast-iron Buddhas, each about 30 inches tall. A stone in the wall of the hall gives the date 823 A.D., but B. Tokiwa[7] thinks from their appearance that the statues were cast in 960–1127 A.D. In the same temple there is a stele that says, *inter alia*, that a man named Chan donated an iron statue of Maitreya to the temple in 738 A.D.

In 1909 a cast-iron stove was disinterred from a Han-dynasty grave in Shensi. It is described[8] by Berthold Laufer, who later acquired it and numerous other cast-iron objects belonging to the same period for the Field Museum. He has also described[9] and illustrated cast-iron spears and swords that he assigns to the period 25–220 A.D. Possibly these were ceremonial weapons, for cast iron would be a poor material for combative purposes. The Royal Ontario Museum of Archæology, at Toronto, Canada, also has acquired many Chinese objects of cast iron belonging to the period 206 B.C.-220 A.D. There can be no doubt that these objects were cast, for not only can the mold marks be plainly seen on some of them but the metal of others has been analyzed and microscopically examined.

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[7] Buddhist Monuments of China, Tokyo, 1926; reference in Vol. 3, pp. 2–3.

[8] The Beginnings of Porcelain in China, *Field Museum of Nat. Hist. Publ. 192* (*Anthropol. Ser., Vol. 15, No. 2*), Chicago, 1917, pp. 79–80 and Plate II.

[9] Chinese Clay Figures, Part 1, *ibid., 177* (*Anthropol. Ser., Vol. 13, No 2*), Chicago, 1914.

FIG. 2—Examples of early Chinese cast iron. Upper left: the largest cast-iron statue ever made; cast between 950 and 960 A.D., Tsangchow, Hopei. Upper right: the oldest dated cast-iron cannon known, cast in 1377 A.D.; it is now in the Provincial Library at Taiyuan, Shansi. Lower left (photograph by L. C. Goodrich): iron statue at the Ching-ssu temple near Taiyuan, cast 1097 A.D. Lower right: cast-iron bell at Pingtingchow, Hopei, cast 1079 A.D.

Literary references carry cast iron in China back to at least the sixth century before Christ. Lassen[10] says Stanilaus Julien told him that the people of Fergana, in the second century before Christ, learned from deserters from Chinese armies how to cast iron, but I have not yet been able to learn the source of Julien's statement. In the Tso Chuan, which is considered to have been written not later than the third century before Christ, it is said that in 513 B.C. two officials of the state of Ts'in requisitioned 480 catties (650 pounds) of iron in order to cast a tripod on which the criminal code was inscribed. In the Kuo Yü, considered to be a compilation of historical anecdotes in part at least as old as the second century before Christ, there is a description of culture in the Chou dynasty (12th century, or later, to 6th century B.C.) that lists the various implements and tools of iron that a farmer, a woodworker, and a seamstress should have. It is not specified whether these were wrought or cast iron, but, since the Chinese still use cast-iron plowshares, it does not seem unreasonable to assume that some of them were cast, more especially since most of the earliest Chinese iron we have is cast, not wrought.

It is a well established fact that in 115 B.C. the Chinese government took over the iron industry and made a state monopoly of it. Various industrialists who had "amassed princely fortunes" are mentioned by name, and in the Yen Tieh Lun,[11] which is a report of a hearing, in

[10] Christian Lassen: Indische Alterthumskunde, 2nd edit., Leipzig, 1858–1874: reference in Vol. 2, p. 620.

[11] An English translation of part of this work, by Esson M. Gale, was published at Leiden in 1931 under the title "Discourses on Salt and Iron."

81 B.C., before the emperor Chao on a petition to have the monopoly abolished, one of the arguments that the Lord Grand Secretary uses in its defense is that subjects who acquire such wealth are encouraged thereby to rebel against the state. This seems a clear indication of a flourishing iron industry in China by the second century before Christ. There is abundant evidence that an important use of iron was for making the pans in which brine was evaporated to make salt, and as far back as they can be traced these salt pans are of cast iron. Some of the statements in the text referred to above prove clearly, I think, that coal, not charcoal, was used in producing the iron.

FIG. 3—Cast-iron animals from China dated prior to 200 B.C. Photograph by courtesy of the Royal Ontario Museum of Archeology.

This brief summary of the evidence that the Chinese cast iron certainly as early as the second, and possibly earlier than the sixth, century before Christ may now be contrasted with Pausanias' statement that Theodorus the Samian made the first cast iron in Greece in the sixth century before Christ. Two questions at once arise. The first is whether the Chinese learned from the Greeks how to cast iron or the Greeks learned from the Chinese, assuming this is a case of cultural transference. The latter appears more probable, since the Chinese made much cast iron and the Greeks very little, but either assumption involves an earlier contact between the two people that is not supported by acceptable evidence. The other question is why, when the Greeks had learned the process of casting iron, they used it so little. My suggestion is that iron, in the West, was more expensive than bronze and harder to work with, so it was seldom used for casting.

IRONWORKING IN INDIA

There is an abundant literature on the contacts between India and China. How early it began need not concern us, for we can find no important use of cast iron in India before the eighteenth century, when the art was introduced from Europe. A single piece of cast iron found in India is considered to be no earlier than the eighth or tenth

century of our era; this is a shapeless 120-pound lump, which, it is suggested, may have been made by accident. The famous third or fourth-century iron pillar at Delhi has been analyzed and found to contain less than two pounds of carbon to the ton. It, like early Indian cannon, was unquestionably made by welding together blooms of almost carbon-free metal. This immediately raises another question; why did not the metal workers of India, in the course of more than a thousand years of contact with China, learn from the Chinese how to cast iron?

FIG. 4—Cast-iron pans like these have been an object of commerce since the earliest times. The hills beside the trail are piles of refuse from smelting operations.

IRON METALLURGY IN SHANSI

A possible explanation may lie in some observations I made 24 years ago, without attaching more than technical significance to them at the time. Early in 1910, in company with C. H. Wang and F. N. Lu, I visited the iron district of Pingtingchow, Shansi (where the big iron bell was cast in 1079 A.D.), to observe metallurgical methods and to collect specimens of raw materials and products.[12] We found the natives producing iron by an unusual method. The ore was reduced in crucibles (Fig. 5) instead of in a furnace like that shown in Figure 1. The furnace in Figure 1 is blown with a blast, that in Figure 5 operates by natural draft. When the crucible is withdrawn and emptied, there is obtained from it a spongy bloom of almost carbon-free iron about the size of a loaf of French bread and many smaller particles of iron. The malleable bloom is worked up into wrought-iron objects that are later casehardened for uses where hardness is essential. The smaller particles of iron are transferred to the crucibles shown in the hearth of the furnace (Fig. 6). These are blown with a blast and produce melted iron that runs perfectly in the molds and is cast into objects of surprising thinness. When we asked the workmen how they were able to make such thin castings, they ascribed it to a substance, which they called *hei-tu*, that they are careful to add to each batch.

Examination showed that the *hei-tu* was associated with the coal used and that it contained abundant crystals of vivianite, iron phosphate. Analysis of the coal revealed that it also contained phos-

[12] The detailed report of our findings was published in the *Transactions of the American Institute of Mining Engineers* for 1912 (Vol. 43, pp. 1–53).

phorus. The iron ore used contained only ½ to 1 per cent phosphorus, and cast iron made from it in the ordinary way should not contain over 1 per cent. But the finished iron castings contained 5 to 7 per cent phosphorus, the additional amount having been taken up from the coal and *hei-tu*. While I recognized at the time that it was its phosphorus content that made the molten iron fluid, it was not until many

FIG. 5

FIG. 6

FIG. 5—Iron ore is reduced to metal in these furnaces. The product is unfused metal that is next melted for casting.

FIG. 6—The unfused metal produced in the furnace shown in Figure 6 is melted in these crucibles The lower group are on the bottom of the furnace, which is blown by a bellows inside the structure at the back. The fused metal is then cast.

years later that my attention was called to the studies of Wüst,[13] who has shown that iron containing 6.7 per cent phosphorus has a melting point of 980° C., or 100° C. below that of copper and 200° C. below the iron-carbon alloy of the lowest melting point.

If the Chinese twenty centuries earlier used the same methods that they did in 1910 it was the adventitious occurrence of phosphorus in Shansi coal that permitted them to make a metal that would fuse at a low enough temperature for casting. Unfortunately for the hypothesis, the few analyses made of early Chinese iron do not show a high phosphorus content, so it must be left as a mere suggestion until either refuted or confirmed by additional work. Even if the addition of phosphorus proves to be a relatively recent development, the general method of first reducing the ore to metal followed by resmelting in crucibles in a blast-operated furnace may be a sufficient explanation as to why the Chinese, with an abundant local supply of coal for fuel, were able to produce cast iron so cheaply that it was more economical than bronze for common use. It must be remembered that nowhere in the ancient world except in China was iron reduced from its ores with coal; everywhere else charcoal was used. The first recorded Western attempts to use coal as fuel in iron making were made in

[13] W. H. Hatfield: Cast Iron, 3rd edit., London, 1928, p. 59.

England in the seventeenth century and were not brought to success until 100 years later. Coal is likely to be high in sulphur, which enters the iron and spoils its quality. The Shansi coal, however, happens to be low in sulphur.

This serves to answer the questions why the casting of iron was

FIG. 7—Iron smelting in Shansi province. Opening a furnace and removing the crucibles. Pingting-chow, 1918.

not introduced into India from China and why the Greeks and Romans did so little casting in iron. They did not have the same raw materials as the Chinese had, and Chinese methods applied to their materials would not produce the same results.

STEEL IN INDIA AND CHINA

Though the metallurgists of India did not develop the casting of iron, they were the first to hit on the making of true steel by what is known in modern parlance as the crucible-steel method. They improved their furnace equipment so that it was capable of producing a temperature at which iron containing one per cent, or less, of carbon could be melted; by melting the nearly carbon-free iron, produced by the reduction of iron ore, with just enough carbon they produced steel. At a much later date the same general method appears in Europe, but even as late as the middle of the eighteenth century, it is said, the best steel was imported from India. The Indian method never appeared in China; all the steel used there has apparently always been made by the cementation, or casehardening, method already described.

What has been said perhaps furnishes the answer to the question, which has recently been puzzling Chinese scholars, how it happened that the first use of iron weapons in China seems to have been in the Yangtze Valley, though all the evidence points to an earlier use of iron for other purposes north and west of that region. W. H. Wêng has

suggested[14] as an explanation that the iron ore in the Yangtze Valley region was of better quality and thus facilitated the making of good steel. Good steel could be made from the ore found in both regions, but the workers in the Yangtze Valley undoubtedly used charcoal for fuel and thus escaped the brittleness imparted to the metal by the phosphorus in the coal used as fuel in Shansi and Shensi. This, however, leads me to the further suggestion that possibly the first iron used in the latter region was cast iron, and the working of blooms into articles of wrought iron or steel was there a later art, instead of an earlier, as it unquestionably is everywhere else in the world. Such a possibility seems never to have been considered, but the evidence reviewed here, especially the cast-iron swords and spears described by Laufer, makes it distinctly worth considering. It is hard to imagine any metal less suitable for making swords and spears than high-phosphorus cast iron; that they were made from it suggests that the ironworkers there did not know how to make them in any other way at that time.

Ironworking: Stages and Places

Our present knowledge of the history of cast iron tends to refute rather than support the general belief of archeologists that the reduction of iron from its ores was invented by the Hittites[15] and its practice spread from that point of origin over the ancient world. I have elsewhere pointed out[16] that man's first work on metals was undoubtedly the mechanical working into useful shapes of pieces of native metal, usually copper or gold, that he picked up. Later, with the aid of a blowpipe, he became able to melt small pieces of metal so as to yield a mass of workable size. This led to the discovery of smelting, by which metal was derived from that which was not metal. Once this discovery was made, the smelters would naturally try every mineral to see what could be obtained from it. The production of iron from iron oxide might have been somewhat delayed by failure to learn quickly that, while copper, lead, and tin could be produced in the presence of excess carbon dioxide, iron could not; but this knowledge must have been first attained much earlier than Hittite times. What the Hittites seem to have been the first to learn was how to control the carbon content of iron so as to produce metal capable of being hardened. By 600 B.C. the production of hardened iron was widely known in Western Asia, but up to that time no one had there melted and cast iron. The invention of iron casting would seem to have occurred almost simultaneously but probably independently in Europe and

[14] Chui Chih Chi, Peiping, 1930.

[15] Harold Peake: The Origin and Early Spread of Ironworking, *Geogr. Rev.*, Vol. 23, 1933, pp. 639–652.

[16] *American Journal of Archaeology.* (In press.)

China. Though there was much intercourse between China and India, the casting of iron did not spread from the former to the latter, nor did the later art of making true steel, invented in India, spread from there into China. Even in China the native methods of iron production in Yunnan and Szechwan are allied to those of India and are basically different from those used in Shansi.

Hence it seems reasonable to conclude that, while a knowledge of ironworking sometimes spread from one region to another where natural conditions were essentially similar, the weight of evidence indicates that the methods used in a given region are sometimes, perhaps usually, the result of intelligent empirical experiment with the raw materials there available. We have a modern example of this. At Butte, Mont., half a century ago it was noticed that scrap iron would precipitate copper from the mine water. From this the observers proceeded to develop a practical method of copper production, in complete ignorance of the fact that they were redeveloping a method employed by the Chinese from at least the thirteenth century and long used on a large scale in Europe. It seems altogether likely that elsewhere and at other times people found out for themselves how to do things, instead of learning from those who had first discovered the method and had practiced it elsewhere.

THE GEOGRAPHIC BACKGROUND OF THE SAAR PROBLEM*

Hubert A. Bauer

EARLY in June the Council of the League of Nations announced that accord had been reached on the terms of the Saar plebiscite to be held in 1935 in conformity with the terms of the Treaty of Versailles. The problem of the future of the Saar Territory, soon to be decided, is mainly of an economic nature strongly permeated with national and racial ambitions. But the basic issue cannot be detached from the geographic background to which the region owes its economic development nor severed from the geographic relations that so far have controlled its economic front. The acuteness of the problem is enhanced by two outstanding geographic factors, the obvious lack of strict physical delimitation and the unique neighborhood of Saar coal and Lorraine minette ore.

Environmental Considerations

Ever since the Saar Territory became embodied in the Treaty of Versailles as a temporary political creation the term "Bassin de la Sarre" or "Saar Basin" has been in general usage. The expression "basin" invites the conception of a geographical unit. But neither geologically nor physiographically are there strong reasons justifying such a conception, unless the entire drainage area of the Saar be considered a basin. In any other respect the territory represents rather a multicolored mosaic of regional fragments, each reflected in the changing aspect of the landscape. "Elle intéresse tout le cercle d'influence du bassin houiller, sans égard aux limites politiques anciennes du Palatinat bavarois et de la Prusse rhénane, ni aux différences d'aspect du sol," says De Martonne.[1]

The productive core of the territory centers about the coal measures whose pitching folds underlie the southeastern part of the Saar-Nahe graben, a region of low hills eroded from Permian and Triassic sandstones. In contrast with this heavily forested central area stand the almost bare plateaus of the Bliesgau in the extreme east and of the Saargau in the extreme west, both developed on the Triassic limestones of the Côtes de Lorraine. The north belongs to the foreland of the slaty Hunsrück.

*This article is based on first-hand impressions that the writer obtained while visiting the Saar Territory in 1924. The following works, among others, have been consulted: L. Maisch: Zum Verständnis für das Saargebiet und zur Verständigung, Solothurn, 1933; various articles in *Die Deutsche Berufs-Erziehung*, Berlin-Leipzig, Feb. 11. 1934; *Zeitschrift für Kommunalwirtschaft*, Vol. 23, No. 23, 1934; Walther Cartellieri: Wirtschaftskunde des Saargebietes, Saarlouis, 1934.

Also see the review of the "Saar-Atlas" by Richard Hartshorne elsewhere in this number of the *Geographical Review*.—Edit. Note.

[1] Emm. de Martonne: Europe Centrale, Part 1 (Géographie Universelle, Vol. 4), Paris, 1930, p. 152.

Bounded, then, by the Rhenish Slate Mountains on the northwest and by the Hardt Mountains on the east, the Saar Territory forms part of the Lorraine Gate, affording easy access to the Rhine by two routes, a northern route through the Nahe graben into the Mainz (Mayence) basin and a southern route through the Kaiserslautern depression of the Rhenish Palatinate towards Ludwigshafen. It was through this gateway that in 1870 the German armies invaded France. The battlefield of Spichern immediately beyond the present French line overlooks the important sandstone basin of the Warndt, which holds an almost untouched reserve of best Saar coal.

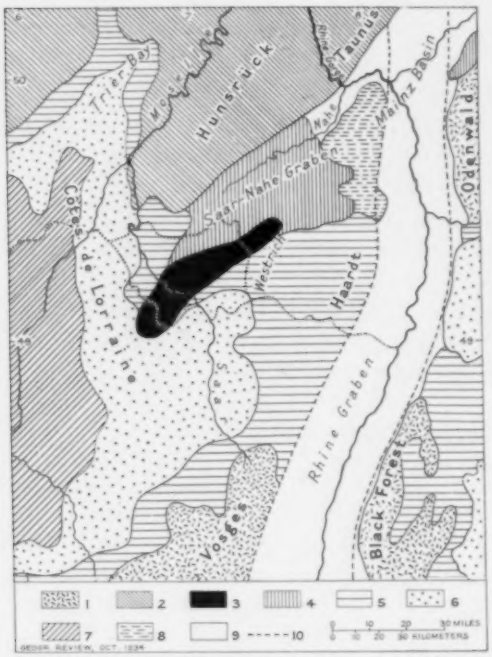

FIG. 1—The Saar Basin and adjacent regions. Key to rock formations: 1, Igneous; 2, Devonian; 3, Carboniferous; 4, Permian; 5, Triassic (Bunter); 6, Triassic (Muschelkalk and Keuper); 7, Jurassic; 8, Tertiary; 9, Quaternary; 10, fault lines. Political boundaries are shown by a dotted line. After *Deutsche Berufs-Erziehung*, Feb. 11, 1934.

The term "Kohlengebirge," as the Saarlander calls his native coal-bearing hills, is more accurately applied to the geological than to the topographical configuration. The coal-bearing strata occur in a huge anticline whose apex lies near Saarbrücken, known as the "Saarbrücker Hauptsattel." The axis strikes northeast to southwest but pitches also in both these directions. On the west the coal measures dip in gentle undulations beneath heavy strata of younger rock out of the reach of profitable mining. Numerous transverse faults separate the seams into countless benches. An extensive thrust fault, the "Saarbrücker Hauptsprung" and the "Saarsprung," until recently thought to be a common strike fault, terminates the present mining area abruptly on the east and southeast. Altogether, there are some thirty workable seams, aggregating 38 to 43 meters in thickness.

An Ideal Industrial Area

The northeast trend of the coal measures forms the vital axis of the area, while another strong line of industrial development is constituted by the northwest trend of the Saar trench, which crosses the

entire width of the Lorraine Gate, cutting through the coal at Saarbrücken. This makes Saarbrücken and its vicinity the industrial heart of the region and the hub of the traffic wheel. Most of the 166 coal mines crowd along the innermost line of best gas coal, while the iron and steel industry with its seven giant plants logically follows

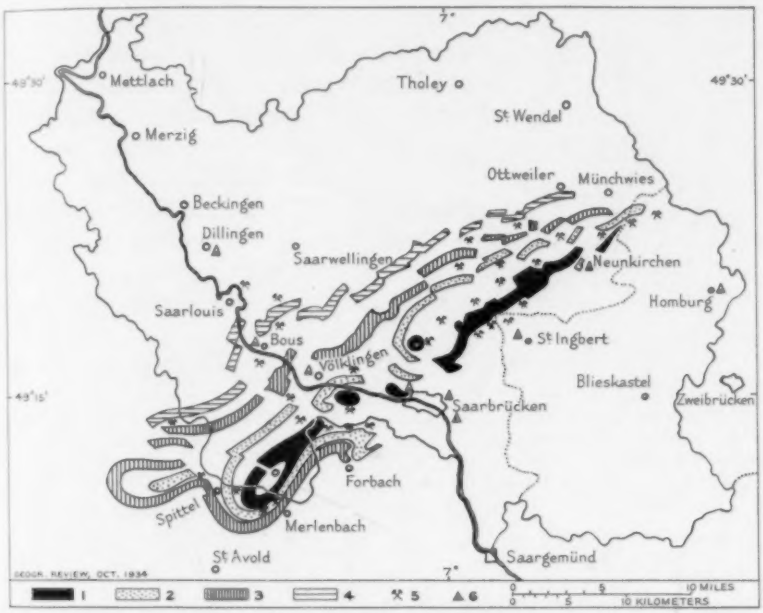

FIG. 2—Coal seams, mines, and steel mills of the Saar. Key: 1, fat coal; 2, upper steam coal; 3, lower steam coal; 4, meager coal; 5, coal mines; 6, steel mills. The Saar Territory is bounded by a solid line. The dotted line represents the boundary between the Rhine Province and the Bavarian Palatinate out of parts of which the territory was constituted. Scale 1 : 650,000. (After W. Cartellieri: Wirtschaftskunde des Saargebietes.)

the two vital lines northeastward to Neunkirchen and northwestward to Dillingen.

Early exhaustion of local ore pockets and the change from charcoal to coke were in the main the causes of the intimate association between Saar coal and Lorraine ore—a development that between 1871 and 1918 led to a natural expansion of the iron and steel industry into the then German ore fields on the west bank of the Moselle, only 50 miles away. Next to the mining of coal and the making of steel, the glass and ceramic industry ranks as a key industry of the Saar, while a number of less important industries, including lumber, chemicals, leather, and textiles, round out the well organized economic structure of the region. The growth and expansion of these industries, especially of iron and steel, have in turn increased the basic coal-mining industry, which finds a ready local market for more than one-third of its output.

Unlike other crowded industrial centers,[2] the Saar Territory does not know the typical crowding of mills and tenements into veritable monsters of industrial concentration. While the visitor cannot fail to be impressed by the number and size of industrial structures, he is surprised to find this dense population of 800,000 scattered over a flowing landscape of fields and forests, living in clean, even charming, villages around the mine shafts and in attractive colonies and homesteads around the blast furnaces and steel mills. Thirty-six per cent of the miners are homesteaders. It is this close interrelation of industrial occupation and rural life that gives the Saar Territory its peculiar stamp, breeding in normal times that exceptional type of miner and mill worker who combines innately industrial leanings with rural habits.

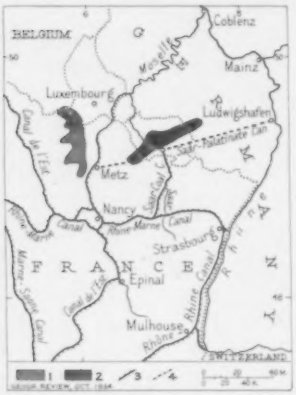

FIG. 3—Waterways connecting with the Saar Basin. Key: 1, Lorraine minette field; 2, Saar coal field; 3, canals; 4, proposed canals. Scale 1 : 7,000,000.

THE QUESTION OF TRANSPORTATION

Before the war the Saar, connected with Germany by an adequate network of railways and with Lorraine and France by both rail and canal, enjoyed a fair economic balance in its exchange of raw materials, finished products, and food. Its coal markets were logical, extending over southwestern Germany into Switzerland and Italy and including a part of eastern France. Evidently the inferior quality of the Saar coal (inferior for coke but excellent for gas and steam) was well balanced by its location as the southernmost of the larger European fields, the only other southern field being that of St. Etienne. Considering the dominant rôle that freight differentials play in the marketing of coal, the lack of a direct water connection with the Rhine over German territory turned into a decided handicap when under French management the Saar became severed from its former German markets by tariff barriers and by an unwise price policy. Physiographic encouragement, to be sure, was not lacking. It was chiefly the pre-war orientation of the Saar towards Lorraine that precluded the otherwise only too logical development of a Rhine-Saar canal. The years after 1871 solved the increasing traffic problem by railway building and by canalizing the Lorraine section of the Saar and the Moselle, but these canals, besides being technically antiquated, are now all on French territory. The Saar coal canal reaches the Rhine-Marne canal halfway between Nancy and Strasbourg, thus

[2] With a population density of 431 to the square kilometer the Saar Territory is the most densely populated area of Europe, considerably exceeding Saxony (347), Belgium (266), and England (264); it has more than three times the average density of Germany (139).

gaining access to the Rhine in Alsace and to the Lorraine ore fields over the canalized Moselle. Nothing illustrates better the struggle over the future economic orientation of the Saar than the two opposing canal projects recently advanced, the German project of a Saar-Palatinate canal and the French plan of a Saar-Moselle canalization. The German plan clearly reflects the endeavor to rewin the lost South German market in the face of growing competition from the Rhenish Westphalian and Ruhr fields. The latter not only possesses the better coking coal but has increased its competitive strength by canalizing the Lippe and completing the Rhine-Herne canal. The Saar coalfield today ships only 5 per cent of its output by water, while the Ruhr field ships 50 per cent.

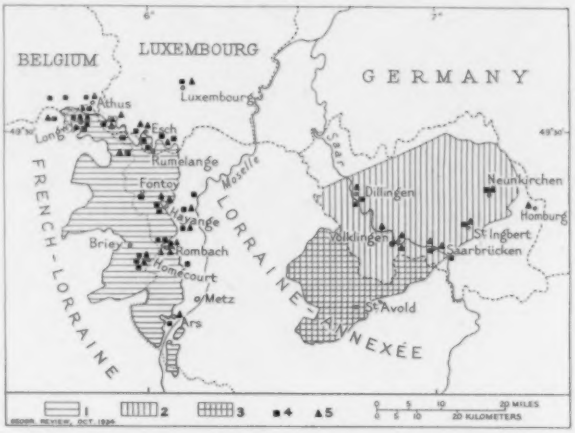

FIG. 4—The iron and steel industry of Lorraine and Saar. Key: 1, minette ore deposits; 2, German Saar coal; 3, French Saar coal; 4, blast furnaces; 5, steel mills. Revised and adapted from A. H. Brooks and M. F. La Croix (see footnote 4).

The projected route of the Saar-Palatinate canal provides an almost straight connection of Saarbrücken with Ludwigshafen, with only a few topographic difficulties in the way. Starting near Saarbrücken, the line leads through the valley of the Wogbach to the low divide between the Saar and the Blies, then continues for an even 65 kilometers through the valley of the Blies and the Kaiserslautern depression, whence it crosses the crest of the Hardt in a 35-meter cut, to descend finally through the valley of the Alsenz and the Eisenstädt basin into the Rhine graben. Only two lift works, one tunnel one kilometer in length, and several pumping stations would be required for the entire length of 132 kilometers.

The French project of a Saar-Moselle waterway has—from the German viewpoint—several disadvantages. Its economic direction towards its rival on the lower Rhine would be anything but logical, and its almost double length would mean an unfavorable freight differential in respect to the South German market. It would, however, undoubtedly be of great value to Lorraine and Luxembourg.

A new angle to the German Saar-Palatinate canal project is furnished by a second French plan, which would provide a waterway between Metz and the Lorraine section of the Saar coalfield. This

would bring the heads of the two projected canals within 14 kilometers of each other, and their connection could easily be made a point in the future French-German economic understanding, in which the Saar Territory is bound to play an essential rôle.

FIG. 5—Panorama in the lower Saar valley: looking from Ayl to Schoden. (This and the following photographs by A. Rupp are reproduced by courtesy of the Reichsbahnzentrale für den Deutschen Reiseverkehr, Berlin.)

MINETTE ORE AND SAAR COAL: THE COKE PROBLEM OF LORRAINE

It is rather reassuring to believe that geographic relations are stronger than political animosity and economic rivalry. Such is the belief of an outstanding steel industrialist of the Saar, Dr. Hermann Roechling, whose opinion is grounded in a wide experience in inter-European steel affairs extending well beyond the Saar into Lorraine and Luxembourg. It is Roechling's contention that the unique neighborhood of Saar coal and Lorraine ore, which has its parallel only in Birmingham, Alabama, cannot be disturbed by any political boundary line.[3] This probably reflects the attitude of the more conservative part of the Saar population, which has shown not only confidence in the economic future of the third Reich but an awareness of the true and ultimate function of a borderland such as the Saar.

The Lorraine field is by far the most important iron-ore deposit of Europe. It furnished, in 1913, 48 million tons, or 44 per cent, of the ore consumed by the entire European iron and steel industry: 95 per cent of French iron and 50 per cent of German iron were produced from ore mined in the Lorraine field. Of this huge total only

[3] Hermann Roechling: Wirtschaftsfragen der Saargebiete, *Die Deutsche Berufs-Erziehung*, Vol. 49, February, 1934.

about 5 million tons are being reduced annually in Saar furnaces, while many times that amount is being smelted in the furnaces of Lorraine. Among the continental coal reserves tributary to the Lorraine ironworking industry by virtue of relative proximity, the

FIG. 6—In the lower Saar valley: Serrig in the midst of its vineyards.

Saar Territory in 1919 ranked second (15 per cent) to the Westphalian field, which led by a wide margin (69 per cent). The west-Rhenish German field, the Valenciennes field, and the Belgian field made up the balance.[4] Unfortunately, these figures do not reveal just how much of the Westphalian coal or coke supplied in 1919 must be booked on the reparation account. While it is true that Saar coal yields only 50 per cent coke, compared with 78 per cent from the excellent Westphalian coal, and while it is also true that the latter, owing to more efficient mining methods and shipping facilities, can compete in a much wider market than the Saar coal, these reasons do not seem to be sufficient to warrant the restriction of the use of Saar coal in the minette field to as little as 15 per cent. It must be recalled that the Saar enjoys a decided freight-rate advantage over the Rhenish field. In fact, as recent statistics show,[5] Saar coal is now being used to a considerable extent as admixture in the coking plants that the Lorraine producers are installing in ever growing numbers with intensive utilization of by-products, especially of gas for their own plants. If this gain of Saar coal over its more distant competitors, Westphalian and English coking coal, continues to be

[4] A. H. Brooks and M. F. La Croix: The Iron and Associated Industries of Lorraine, the Sarre District, Luxemburg, and Belgium, *U. S. Geol. Survey Bull. 703*, 1920.

[5] Erich Haarmann: Die wirtschaftsgeologische Lage des Saargebiets, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 85, 1933, pp. 383–397.

permanent, even after the possible return of the Saar mines to their German owners, it will be nothing more than the final victory of normal geographic relations over abnormal political-economic conditions such as existed during the unsettled period of reparation.

FIG. 7—Wooded slopes of the winding Saar.

THE ORE PROBLEM OF THE SAAR

It would be wrong to view the Saar problem of today in the light of the past fifteen years, which, indeed, have necessitated profound changes in the policy of the German-owned steel industry of the Saar and which naturally have shifted the coal front to the west. Minette ore, on which the furnaces and mills had been almost exclusively dependent for Thomas steel, used to come from Lorraine mines owned by the steel interests themselves. With the creation of the Saar Territory the price of Lorraine ore rose almost 100 per cent for the German-owned mills of the Saar, thus lowering their competitive strength in traditional Thomas steel. Slowly and in the face of many difficulties the Saar adjusted itself to this handicap by turning to the more costly Martin steel, made chiefly from scrap iron. This readjustment in turn involved a change to higher quality and to a finer type of mill products with new market requirements. That the Saar mills succeeded in this readjustment so well that its new quality products conquered a ready market in Germany as well as in other parts of Europe is perhaps one of the most remarkable effects of the boundary regulation of 1918, much in line with the general post-war trend of German manufacture, namely to balance quantitative losses by gains in quality.

While such necessary changes are likely to become permanent features by sheer inertia, it would again be wrong to construct from them also a permanent separation of those Siamese twins, Saar coal and French minette. The problem must, on the contrary, be viewed

FIG. 8—An industrial scene in the Saar; Burbach, municipality of Saarbrücken.

in the light of that natural reciprocity invited by the close geographic relationship of the two basic raw materials. If the Saar-Rhine canal plan should materialize in years to come, this present dependence would probably lose something of its strength, yielding to the change in geographical relations.

THE VITAL COAL PROBLEM

The Saar is essentially a coal-mining region. Its other industrial pursuits with few exceptions are based on the undisturbed and profitable utilization of its black wealth. In its endeavor to change the coal front of the Saar from east to west the French administration has deliberately neglected the German market. In 1932 Germany consumed only one-fourth its former share of Saar coal. Switzerland now takes half its pre-war quota; only Italy has increased its market for Saar coal. The quite considerable local market has remained stationary, chiefly because the steel industry has been able to hold its own in the general depression. The foremost consumers of Saar coal in France are, however, not the Lorraine coking plants, which take some 900,000 tons annually as admixture to Rhenish and British coal. Since the Saar coal is excellent for steam and gas, French railways and gas plants are using the Saar product with great ad-

vantage, altogether some two million tons per annum. There are distinct reasons to believe that this westward orientation of the Saar coal market will continue for many years after the possible return of the mines to Germany. The French consumers can hardly afford to give up a coal so cheap and so well suited to their purposes without facing a painful increase of their manufacturing and operating cost. A wise tariff and freight policy on the part of the Reich will be needed to retain the new customer, at least as long as the German market has not been fully recovered. Even the newly opened mines in the Lorraine section of the Saar field will not be able to replace more than a small part of the present supply of gas and steam coal to France. The southern end of the Saar field is rather poor in "fat coal," and the seams lie generally too deep for profitable mining under present methods.

Naturally these fifteen years of French ownership have been years of exploitation rather than development. Mine management has been less efficient: modern methods that have increased the efficiency of the Rhenish Westphalian field by 47 per cent during the past ten years are still unknown in the shafts and tipples of the Saar.

The coal industry of the Saar Territory faces, therefore, three problems of equal magnitude—the problem of retaining its present market in France, that of recovering its lost market in Germany, and, closely associated with this, the problem of quick rationalization. As all three are government problems, their solution may be anticipated as possible, once the Saar is restored to a regularized economic life.

The Problem of the Warndt

The unusual procedure of French mining companies of mining Saar coal from Lorraine territory, at the same time obtaining 99 years' leases for the undermined districts, has aroused a good deal of indignation in Germany and will probably constitute one of the most acute legal problems of the situation. It is not the purpose of this paper to enter into any political controversy, but the geographical background to this political problem is not without interest. The Warndt, that southern section of the Saar Territory surrounded on three sides by Lorraine, owes its preserved wealth of coking coal and gas coal to a cover of highly aquiferous Bunter sandstone. Lack of adequate mining methods combined with a policy of economy on the part of the Prussian administration retarded its early utilization, thus making the Warndt a veritable coal reserve. Permanent control of the Warndt would offer another advantage to France in that the last commanding ridges of the Côtes de Lorraine, extending to the left bank of the Saar River and including the entire Warndt basin, would form an ideal link in the natural defense of the country.

Conclusion

It may be a matter of first political importance whether the French-German boundary line runs south or north of the Saar River; but, when viewed in the light of geographical relations, the political issue loses some of its acridity. Ultimately the true boundaries of a borderland area such as the Saar Territory are controlled by wise industrial planning rather than by shrewd political bargaining. The "formidable bloc de charbon," from which the Saar population will draw its very lifeblood in the future as it has done in the past, is not only geographically a keystone between French and German lands; it is also destined to play a keystone rôle in the future economic relations between the two great rivals on either side of the Saar.

ZAGAZIG: A COTTON MARKET

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ZAGAZIG, 47 miles northeast of Cairo in the province of Sharqîya, is a city of 53,000 people and one of the chief cotton markets of Egypt. Sharqîya coincides roughly with the old land of Goshen, described in Numbers as a land abounding in fish, cucumbers, melons, leeks, onions, and garlic. The principal city in Biblical times was Per-Sopd, at the eastern edge of the delta. About 950 B.C. Bubastes, a few miles southeast of Zagazig, began to grow in importance, for Sheshonk, whose birthplace it was, made it his capital. It was on the Pelusiac distributary of the Nile, which gave access to the Mediterranean Sea, and a famous shrine enhanced its importance. If Herodotus is to be believed, 700,000 people made the yearly pilgrimage to Bubastes. As in Tanta at the present time, business and religion were combined in an annual fair that attracted traders from every part of the Mediterranean world. After 570 B.C. Bubastes declined in importance because Amasis II neglected the eastern distributaries to favor the Greeks whose trading center was on the Canopic Nile north of Rosetta.

Zagazig's situation favored growth. A natural levee gave it a site above flood level. The Tanitic branch of the Nile connected it with Lake Manzala, and the Sweet Water Canal constructed during the Middle Empire connected it with the east. Before the Arab conquest in 641 A.D. basin irrigation was well developed, canals and drainage ditches were kept in repair, and agriculture flourished. After the conquest unfair taxation and misrule led to a general decline in Egyptian agriculture. The decline was greatest in the eastern delta, where poor drainage converted some 1,500,000 acres of hitherto productive land into saline wastes. The modern period in Zagazig dates from the rule of Mohammed Ali in the first half of the nineteenth century. He deepened the canals, built the first delta barrage, 14 miles north of Cairo, and reintroduced cotton cultivation. Cotton did not become an important crop in Zagazig until the American Civil War, but by 1872 the town was the chief cotton market of the eastern delta.

Mid-delta Climate and Soils

Sharqîya Province, occupying a mid-delta position, enjoys the advantages of climate and soils that have made Lower Egypt so important a producer of fine cotton. The climate of Zagazig bespeaks this situation. It averages 2½ inches of rain in a year—an inch more than Cairo and five or six inches less than Alexandria. Its range of

temperature means is greater by about 4 degrees than that of Alexandria and is a degree or two less than that of Cairo. The January mean is 50° and the July 80°. The lowest recorded temperature is 32° and the highest 117°.[1]

The soils, deriving largely from the volcanic rocks of the Abyssinian

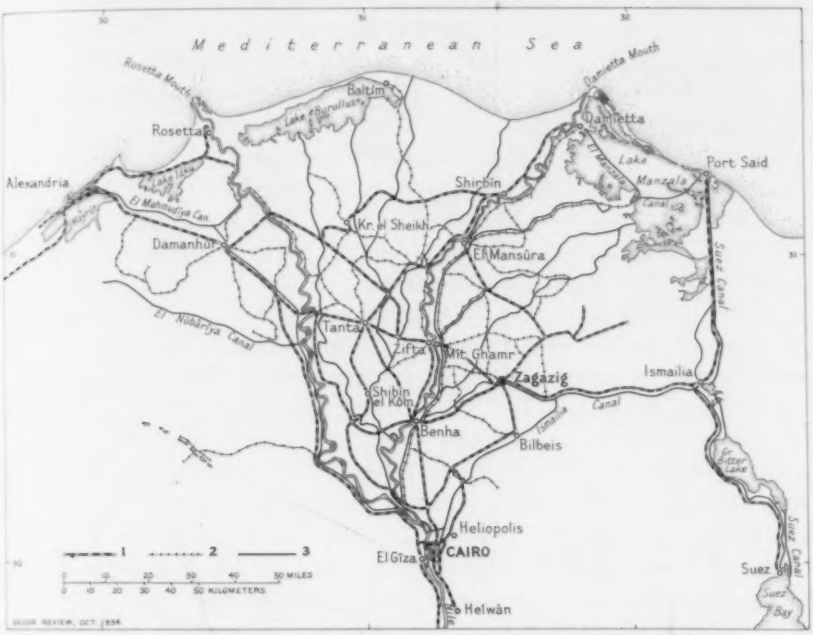

FIG. 1—Map of the Nile delta showing the position of Zagazig in relation to the railways (1, main lines; 2, narrow-gauge lines) and canals (3). Scale 1 : 2,700,000.

highlands, owe their fertility to varied mineral composition and fineness of structure.[2] The mud is formed of particles of minerals reduced to dust by mechanical agencies but chemically unaltered. It contains a large proportion of colloidal clay. It is sticky and plastic when wet and shrinks and cracks on drying—a process beneficial in many ways. The depth of the alluvial deposits of the delta varies from place to place. At Zagazig bed rock was not reached in a boring of 104 meters.[3] At a depth of some 114 feet the clays and sands give way to a water-bearing layer of coarse sand and gravel, which furnishes drinking water for the city during January when the canals are emptied for cleansing purposes. The well water contains a small

[1] On the climatic relations see C. B. Williams: Cotton Growing in Relation to Climate in Egypt and the Sudan, *Egypt, Ministry of Agric., Tech. and Sci. Service Bull. No. 47*, Cairo, 1924. Data are given for Qorshiya, 30 miles northeast of Zagazig and closely similar climatically.

[2] See V. M. Mosséri: The Fertility of Egypt, *Internatl. Rev. of the Sci. and Practice of Agric.*, Vol. 4 (N. S.), 1926, pp. 1–9. See also note in *Geogr. Rev.*, Vol. 17, 1927, pp. 154–156.

[3] J. W. Judd: Second Report on a Series of Specimens of the Deposits of the Nile Delta, Obtained by Boring Operations Undertaken by the Royal Society, *Proc. Royal Soc. of London*, Vol. 61, 1897, pp. 32–40; see also his "Report on a Series of Specimens of the Deposits of the Nile Delta, Obtained by the Recent Boring Operations," *ibid.*, Vol. 39, 1885, pp. 213–227.

amount of sodium carbonate but is superior to the water north of latitude 31° N., which is too saline to be potable.

The surface features of Sharqîya Province have been much changed by man. The natural flatness is broken by canal banks six or eight feet high, upon which are roads. The main canal, the Moes, follows the bed of the Tanitic distributary. The Sweet Water Canal follows the Wadi Tumilat. Branch canals make an irregular checkerboard of the landscape, with an occasional mound of a village ruin or a small copse to break the monotony. The number of trees is surprising. Herodotus mentions them in his account, and Lane-Poole, writing in the eighteen seventies, speaks of the wooded aspect of the country. Trees grow not only along the canals, as in other parts of Egypt, but also in small groups in the fields. Most of them are sunts (one of the acacias) and sycamores, the latter used for making the plows and roof beams. In the swamps are tamarisks.

Sharqîya, however, is not quite so productive as some other parts of the country. In Egypt as a whole less than 24 per cent of the land that can be brought under cultivation is uncultivated. Of the 852,000 acres in Sharqîya Province 38 per cent are waste land—salty marshes in the north and sandy regions in the east. This relatively large amount of waste land accounts for the relatively low population density—526 persons to the square mile, against an average of 1021 for the delta as a whole. In the south and west of the province, where most of the people live, the density averages 850. In 1927, the date of the last census, 527,000 acres were under cultivation, three-fifths of which were double cropped.

Land Tenure and Use

Theoretically all land in Egypt belongs to the crown and is held in life leases. In practice, about one-sixth of the population owns some land, although 69 per cent of the owners have less than one feddan (1.038 acres). Most of the agricultural workers in the Zagazig district are renters. The land is in large estates and is rented for cash or on a crop-sharing basis. Land is valued at $500 to $1000 an acre and rents for $75 an acre. The average value of farm land in Egypt is $515 an acre. Land values in Zagazig are high, but rents are low compared with those near Aswan, where scarcity raises the rent of good land to $125 an acre. The usual practice in Zagazig is to rent on the crop-sharing plan. The landlord who supplies everything but the labor receives four-fifths of the crop; if the cropper supplies everything but the land, the landlord receives three-fifths of the crop. The house of the renter costs little; ten dollars will build and furnish the usual house, and the landlord donates the ground.

In Zagazig the average value of the crops, not including the vege-

tables raised and consumed by the family, is $115 an acre. The average for the delta as a whole is $130. The subinspector of agriculture of the province accounted for this relatively low yield by the fact that the two-year rather than the three-year rotation of crops is usual in Zagazig.

In the so-called "two-year rotation" cotton is planted every summer and wheat or barley and vegetables of various sorts are planted every winter. Durra (maize or millet) is raised on the good land not planted to cotton, and rice—a reclamation crop—is raised on the salt marshes. In the "three-year rotation" a crop of bersim (Alexandrine clover) is raised between the crops of cotton. Bersim improves the soil, increases the yield of cotton, and decreases the bill for commercial fertilizer. Largely as the result of the lack of careful rotation, the yield of cotton has dropped from 478 pounds to the acre to less than 400 pounds. Some Sharqîya land that had been repeatedly planted to cotton yielded only 196 pounds to the acre in 1930. The ordinary distribution of crops in Zagazig is bersim, 16 per cent; durra, 15; cotton, 34; wheat and barley, 34: by double cropping, 122,500 acres of land produce 198,000 crop acres.

In Egypt as a whole durra leads in acreage. It is used locally. Beans and bread made of durra and wheat flour combined are the staple diet of the fellahin. Salt and fenugreek, a sorrel-like green raised in little pots, are mixed with the flour. The dough is tossed on an implement that looks like a crude tennis racket until it forms a cake about ten inches in diameter and one quarter of an inch thick. It is baked in mud ovens fired with durra or cotton stalks.

Landlords and fellahin are interested primarily in cotton—the commercial crop. Some American varieties are grown, but Sakellaridis, a long-staple yellow cotton, is the usual variety. With it the landlord pays his taxes amounting to $7.50 an acre and his labor; with it the fellah pays his rent and buys his few luxuries—kerosene for his lamp, an amulet, a brass cooking pot.

Methods of Production

Methods of production are primitive. Iskander Bey Shadeed, who has a farm of 500 acres near Zagazig, owns a tractor but never uses it. He has fourteen tenant families and hires about two hundred laborers in addition during the harvest. These laborers are paid from fifteen to twenty-five cents a day and are given a bit of land upon which to raise their vegetables. The land is plowed two or three times with a primitive plow, then smoothed with a drag, which is often weighted down with two or three men, then plowed again to turn up the ridges on which the cotton is planted. Holes are made with sticks on both sides of each ridge. Eight or ten seeds are dropped into each

FIG. 2—Archimedean screw, Moes canal.

hole and covered by hand. Later the plants are thinned by hand. The use of commercial fertilizer is increasing, but canal mud is still spread on the fields. All dung is used for fuel. The chief, and often the only, tools are plows, sticks, knives, and heavy hoes.

The women help pick the cotton. Sometimes, too, they sit in the clover fields and cut the clover as far as they can reach using a six-inch sickle. Their jobs are to care for the animals, herd the sheep, make the butter and cheese, and "do their housework in the hardest possible way," as an American missionary said. The homes have almost no conveniences. I visited two hundred of them and saw one bed—a mat on the floor is a luxury—no chairs, one low table, one water filter. There are mud stoves, mud benches, mud utensils, an iron scoop for drawing bread out of the oven, and, occasionally, a brass pan or two!

GOVERNMENT AID

Although British influence has not changed methods of cotton production, with the exception of the use of fertilizer, it has maintained order, secured honest tax collection, and provided a year-around supply of water, agricultural experiment stations, adequate means of transportation, capital to produce and market crops, and a market for the crops produced.

FIG. 3—The houses of 14 tenant families are built round this court.

The main agricultural experiment station is in Cairo, but the next in importance is in Zagazig, where much work has been done to determine the amount and frequency of irrigation necessary to produce the best cotton and to determine also the most effective periods of cultivation. The government supplies selected seed and controls the sale of commercial fertilizer. The Ministry of Agriculture in 1924 started the sale of fertilizer, and it now has a monopoly, for it alone can seize property of less than five acres to cover the debt.

The Agricultural Bank, which was established in 1930, lends money at 1 per cent a month for cotton producing. Its loans are made through the coöperative societies established in 1926. In 1930, 210 societies out of a total of 300 had secured credit in this way. The government advances amounted to forty million dollars. The 60 coöperatives of Sharqîya Province had all had government loans. The landlords are the chief beneficiaries. Although all the fellahin raise their crops on credit, only 9 per cent of them borrowed through the coöperatives in 1930. The usurers supply them with money, and 25 per cent interest is not uncommon. The fellah knows the usurer and his ways; he has a traditional fear of government, and red tape makes government advances slow. Furthermore, the government will not make a loan unless the money is to be spent for seed and fertilizer. The usurer, on the other hand, will advance money for marriage or funeral feasts as well as for seed and fertilizer.

FIG. 4—The entrance to Zagazig's largest grist mill.

No selling is done through the coöperatives; the banks have that function. Each bank in Zagazig has storage yards to which the fellahin bring their cotton and grain. Fifty per cent of the market price is advanced, and when the crops are sold the rest of the money is paid less 20 per cent commission. For an explanation of the 20 per cent commission I was referred to Genesis xli, 33–34. Joseph advised Pharaoh to "look out a man discreet and wise, and set him over the land of Egypt. Let Pharaoh do this, and let him appoint officers over the land, and take up the fifth part of the land of Egypt in the seven plenteous years." In March, 1931, cotton was selling at 10 to 19 cents a pound according to the quality, and wheat at $1.00 a bushel. For the last few years the price of cotton has been too low to yield a profit. To alleviate conditions, the government has renewed its loans to coöperatives, has bought and stored cotton, and has brought about a reduction in acreage. Sharqîya Province planted five-sixths as many acres in 1931 as in 1930.

FIG. 5—Preparing the field for cotton with a native drag.

Marketing Function

As a cotton center, Zagazig helps to supply the world markets; as a livestock and produce center, it supplies in large part the needs of the local district. Here the fellah comes to do his buying and selling. Bartering is not unknown. The local market is held on Tuesday. For

Fig. 6

Fig. 7

Fig. 6—Government storehouse for cotton.
Fig. 7—House of estate owner, Iskander Bey Shadeed.

this the British Marketing Association provides a fenced space and some covered booths. There are no charges for entrance, but exit fees are paid by the owners, new or old. The fee for sheep is 3 cents each; for donkeys, 7½ cents; for camels, 15 cents; and for wheat, one cent a bushel. Vegetables, eggs, homemade cheese, and other perishable products are sold every day by women sitting along the road that runs by the Moes Canal.

Cotton is brought to the city by road, canal, and railroad. There are no paved roads outside the city. The two main canals with their five principal branches and the narrow-gauge railroads that radiate from the city are used much more extensively than the roads. The cotton is taken to one of the five ginning establishments and is put into large bins, where women pick out the stems and leaves for five cents a day. After it is ginned it is sprinkled with an ordinary garden hose and loosely baled with a power baler. It is shipped by the main-line railway to Alexandria or Port Said, pressed into smaller bales, and exported. A narrow-gauge railroad to Lake Manzala and a dredged channel from its terminus to Port Said facilitate traffic in that direction. The Ismailia Canal is little used for any sort of transportation except the occasional shipment of coal from the Suez Canal.

The cotton seed, as well as the cotton, is shipped from Zagazig.

The only oil-pressing factory was not running in 1931. Both wheat and durra are shipped to other parts of Egypt. The grain used locally is ground at home or in small shops by hand or in small mills. The largest mill in Zagazig has a 27-horse-power Diesel engine to turn its one millstone. The milling charge is 12 cents a bushel.

FIG. 8

FIG. 9

FIGS. 8 and 9—Transportation of cotton to Zagazig by camel (Fig. 8) and by light railroad (Fig. 9).

OTHER ACTIVITIES

In addition to the ginneries and grist mills there are two other establishments large enough to be classed as factories. One is an Egyptian-owned ice factory and the other a cigarette factory, which uses Turkish, Bulgarian, and Japanese tobacco. No tobacco is raised in Egypt. In the British American Tobacco factory the capital and the manager are British, the skilled labor is Armenian, and the machinery American.

The bulk of the manufacturing is done in small shops to supply local needs. A small forge makes iron bread scoops, plowshares, and window grilles. Quilts, saddles, mats, baskets, pottery, bricks, wooden sandals, and silver ornaments are other local products. Flax, cotton, and wool are spun and woven in the homes, but the goods in the shops are of British origin. Native tailors make the clothes with Singer sewing machines. The British Foreign Trade Commission estimates that only 14 per cent of the people use foreign goods of any sort.

Zagazig is chiefly a marketing center, but it is a government center, an educational center, and a medical center as well. It has law courts and a modern prison. Prison has no terror for the fellahin. The food is so much better and the work so much easier than they are accustomed to that they regard a prison sentence as a vacation period. An *omdah* of a village near Zagazig regretted that the "good old days

of flogging" were no more. He said that lawbreaking had increased with the abolishment of corporal punishment. As an educational center Zagazig ranks high. A branch of the famous Moslem university, El Azhar, is located here. There are secondary schools for boys and girls, a government trade school, a school for training teachers,

FIG. 10

FIG. 11

FIG. 10—Cotton storage yard at Zagazig.
FIG. 11—Government primary school for boys at Zagazig.

and many private schools. The foreign colonies are large, and each maintains separate schools for boys and girls. The American Mission has a large school, and the Coptic Church two small ones. Real medical service is a luxury in Egypt, but Zagazig has a general hospital, built and equipped by a wealthy citizen, an eye hospital, a leprosy clinic (95 lepers were living in the villages around Zagazig), a child clinic, and a school for training midwives.

The city has a fire department, a water system, telephones, electricity, and mail delivery five times a day seven days in the week. It has no sewerage system, no city transportation system, and few automobiles. I saw one—it belongs to the governor of the province.

OPPORTUNITIES FOR GROWTH

Zagazig's importance as a cotton market does not depend, it seems to me, on the productive advantages of its surroundings so much as on its excellent transportation facilities. Its situation near the junction of the Tanitic distributary and the Wadi Tumilat depression gave impetus to its early growth as a caravan and river mart; the railroads have fostered its recent growth. The main line between Cairo and Port Said was finished in 1858. Somewhat later the branch through Benha to Damietta was completed. As the demand for cot-

ton increased, narrow-gauge lines were extended to all the outlying districts of the city and to the neighboring provinces. The tentacles indicate the city's function as a collecting and distributing center.

In addition to unusual transportation facilities, it has had the advantage for many years of a large number of foreign residents who furnish not only the capital but also the business experience necessary for success in commercial enterprises. The greater number of commercial and financial institutions are controlled by foreigners—four of the five banks, three of the five ginneries, and the one tobacco factory. Syrians, Armenians, Jews, and Greeks own many of the shops. As a result of the Turkish persecution there has been a large influx of Armenians, who are the skilled laborers in the ginneries and in the tobacco factory. Even the railroads and irrigation works had British inspectors until 1922.

As a trade center, Zagazig retains from the past its weekly market, its handicraft industries, its donkey, camel, and canal transportation, and its usurer to furnish credit. Because of foreign influence its marketing function has been enlarged by a commercial crop, by banks that serve not only as credit institutions but as grain and cotton merchants as well, and by modern means of transportation—the railroads. The railroads bring by way of Alexandria nitrate from Chile, cheap cotton goods from Lancashire and Japan, steel disks for the *norag* from Sheffield, and kerosene from Suez and Russia. To pay for these the railroads take Zagazig's cotton and cottonseed, its durra, and its wheat to Cairo and Alexandria. Zagazig is an important cotton market today largely because it is a railroad center.

SOIL MOTTLINGS AND MOUNDS IN NORTHEASTERN TEXAS AS SEEN FROM THE AIR

John L. Rich
University of Cincinnati

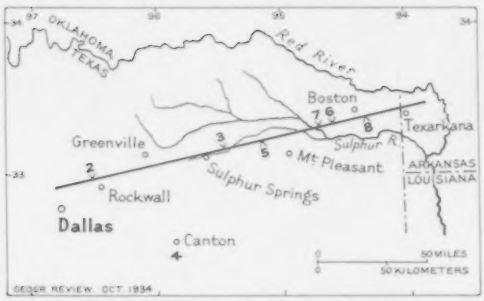

FIG. 1—Map showing the airline from Dallas to Texarkana with locations of photographs. Numbers correspond with text figures.

In the Gulf coastal area of Texas, Louisiana, and adjoining states low, rounded soil mounds are scattered profusely over thousands of square miles of the surface. They cannot fail to excite curiosity, but their origin has been a puzzle and is still imperfectly understood. The coming of the airplane has awakened a new interest in the problem, because the mounds are much more conspicuous from the air than from the ground and because the aerial view or photograph brings out their pattern and their relations to other features so clearly that new possibilities are opened for the discovery of their secret.

A flight from Dallas, Tex., to Texarkana, Ark., along the regular airline offers a splendid opportunity for study of the mounds and of the several intermediate stages in mound development that seem to accompany the change from the black prairies, without mounds, at the western end of the route through a transition zone of scattered bunch brush to the forest land, thickly mound-dotted, at the eastern end.

On a recent flight over that line it was the writer's good fortune to secure a photographic record of these features, which is interesting not only as a contribution to the problem itself but also as a demonstration of what can be done by way of recording geographical features from a regular passenger plane without the use of special equipment. The accompanying pictures were taken with a Leica camera through the far from optically perfect glass of the plane window. The location of each picture was determined by noting to the nearest quarter of a minute the time when it was taken and from which side of the plane, and the route flown was charted by noting the time when railroads, towns, or other objects that could be identified readily on the map were passed. Locations given on the photographs are exact where detailed maps exist. Elsewhere they are believed to be correct to within the nearest mile.

Earlier Explanations of the Mounds

Before turning attention to the accompanying photographs, it would be profitable to review, briefly, some of the more plausible of the suggestions that have already been offered in explanation of the mounds. For a review of the literature and a bibliography, the reader is referred to a paper by Melton.[1] During the years 1905–1908 discussion of the problem was active. Many hypotheses were advanced, some of which, such as that the mounds represent fish nests, or that they were formed by the uprooting of trees by the wind, are obviously inadequate because of scale or of other requirements that are not generally applicable.

The explanation that found most favor in this early discussion was that the mounds were built by ants or burrowing animals. It was pointed out that in Texas and in Cuba ants such as the *Atta* build mounds nearly the size of those under discussion. Against this explanation it has been urged that, in general, the mounds are not now occupied by ants or rodents and that they do not show the chambered structure that might be expected. The latter objection, however, does not seem to the writer to be valid, because the chambers would tend to collapse or be filled if long unoccupied.

Another suggestion has been that the mounds are of human origin—that they mark the crumbled remains of mud houses or that they may have been heaped up for agricultural purposes. However, their great numbers, their lack of definite patterns, and the general absence of artifacts in them are opposed to the idea of human origin.

An explanation that undoubtedly is correct for certain mounds of similar appearance in the Gulf region is that they were accumulated around vents where water or gas came up from below. The evidence, however, does not support such an explanation for the greater number of the mounds. The suggestion has been made repeatedly that the mounds may be products of wind action—formed either by wind blowing the soil away from protecting clumps of vegetation, leaving residual hillocks, or by wind-blown sand or dust collecting around discontinuous masses of vegetation. Somewhat similar mounds have certainly been caused by such processes, but the characteristic wind patterns seem to be generally lacking in the arrangement of those of the Gulf coastal plain.

After his attention had been drawn to the remarkable display

[1] F. A. Melton: "Natural Mounds" of Northeastern Texas, Southern Arkansas, and Northern Louisiana, *Proc. Oklahoma Acad. of Sci.*, Vol. 9, 1929, pp. 119–130; also the abstract of his paper "Erosional Soil Hillocks" in the "Preliminary List of Titles and Abstracts of Papers," 46th Annual Meeting, Geological Society of America, Chicago, 1933, pp. 35–36. See also A. C. Waters and Charles W. Flagler: Origin of the Small Mounds on the Columbia River Plateau, *Amer. Journ. of Sci.*, Ser. 5, Vol. 18, 1929, pp. 209–224 (mounds differing considerably from those of the Gulf region are interpreted as erosional); Max Hannemann: "Mounds" und "Pimples" in der Küstenebene von Texas und Louisiana. *Petermanns Mitt.*, Vol. 74, 1928, pp. 218–224.

of mounds revealed on aerial photographs, Melton, in 1929,[2] reviewed the whole problem and checked in the field the various explanations that had been suggested. By a process of elimination he was led to the hypothesis "that some phase of stream action is responsible for their origin." He suggested that gullying of a loose, friable surface soil down to a more resistant subsoil has left the mounds as residuals between subsidiary gullies. In his 1933 abstract Melton states that further confirmation of this hypothesis has been obtained. The pattern of the mounds differs so radically from normal stream or gully patterns that Melton's explanation is difficult to accept, but in a modified form in which clump vegetation is assigned an important place it receives partial confirmation by the evidence presented herewith.

The Flight and Resulting Conclusions

On the black prairie developed on the outcrop of the Austin chalk and Taylor marl for 15 to 20 miles east of Dallas no soil mottlings or mounds were noted. The rich black soil of the uplands is perfectly uniform in shade. A little farther east small-scale mottlings (Fig. 2) appear on the soil of the flat uplands. These are without distinctive pattern where the ground is most nearly level but take on a distinct rill pattern around the borders where the uplands break down into slopes. It may be suggested that the pattern is due to the former arrangement of the prairie grasses, modified on the slopes by the action of rills, both in guiding the original grass pattern and in modifying the resulting soil pattern after cultivation began.

About 40 miles east of Dallas, south of Greenville, larger-scale soil mottlings of similar pattern appear, but they are rather vague and indefinite. About 30 miles still farther east, in the neighborhood of Sulphur Springs, the mottlings become conspicuous locally (Fig. 3), but, as far as could be determined from the air, they have very slight, if any, relief.

About 35 miles south of the line of flight, near Canton, vertical aerial photographs (Fig. 4) show conspicuous soil mottlings having a pattern somewhat similar to that shown in Figure 3 but showing a distinct correspondence with the pattern of the vegetation. Study on the ground is needed to determine whether there is any relief associated with these mottlings. One is led to wonder whether protection of the areas beneath the trees from the direct beating of the rain might in time leave them standing slightly higher than the exposed spaces between. In a few places a pattern, such as that shown in Figure 4 (right), suggestive of wind influence may have been brought about indirectly by wind control of the tree distribution.

Between 20 and 30 miles beyond Sulphur Springs is an area of

[2] Melton, "Natural Mounds."

FIG. 2—Small-scale soil mottlings on upland near eastern margin of prairie, showing influence of rill action around margins. Center in 32° 58¾′ N.; 96° 31½′ W. Rockwall quadrangle. Looking northwest from elevation of about 1400 feet.

open country, much of it pasture, where the vegetation is transitional between prairie and forest, with clumps of brush, some of it of colonial habit, scattered irregularly over the grassland. The soil here is distinctly mottled (Fig. 5), and the mottlings seem to be closely related to the vegetation, the lighter spots marking present or former clumps of bushes. Some of the mottlings are vague and of indefinite form, others are sharply defined circular areas. The effect of rainwash has been to bring out a flow pattern around the mottlings suggesting that the clump vegetation may have exerted a protective

FIG. 3—Soil mottlings. Probably early stage in development of mounds. About 33° 9′ N.; 95° 28′ W. Looking northerly from about 1000 feet.

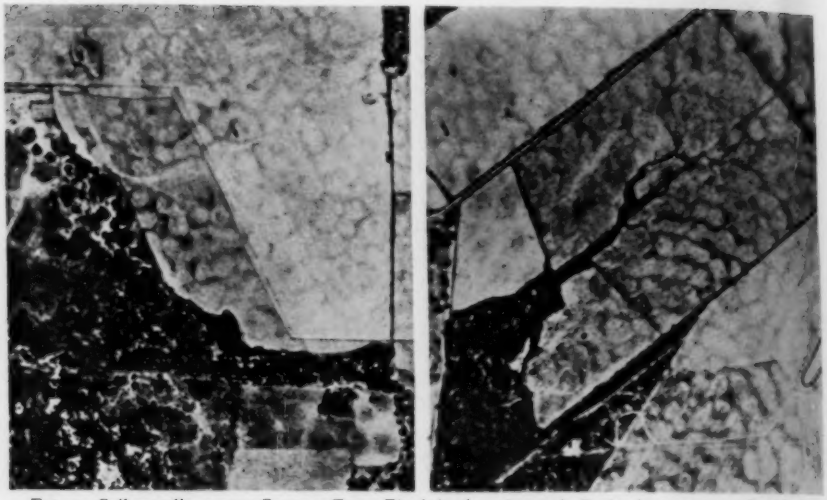

FIG. 4—Soil mottlings near Canton, Tex. The left view shows similarity in pattern and scale between mottlings and tree distribution; the right shows mottlings suggestive of wind influence.

effect against the rainwash, thereby causing low residual mounds to be developed by differential erosion. There is, of course, the reverse possibility that low mounds formed by some other agency have been selectively occupied by the bunch brush; but careful inspection of the photographs supports the belief that it is rather the vegetation that is the cause of the mottlings.

An easy solution of the problem of the mounds by ascribing them to the effects of differential sheetwash on gentle slopes partly protected by bunch vegetation is suggested by the pattern shown in Figure 5, but such an explanation for the mounds in general seems

FIG. 5—Incipient mounds and mottlings in pasture, showing relation to bunch vegetation. Note flow patterns. About 33° 13′ N.; 95° 12′ W. Looking southerly from about 1500 feet.

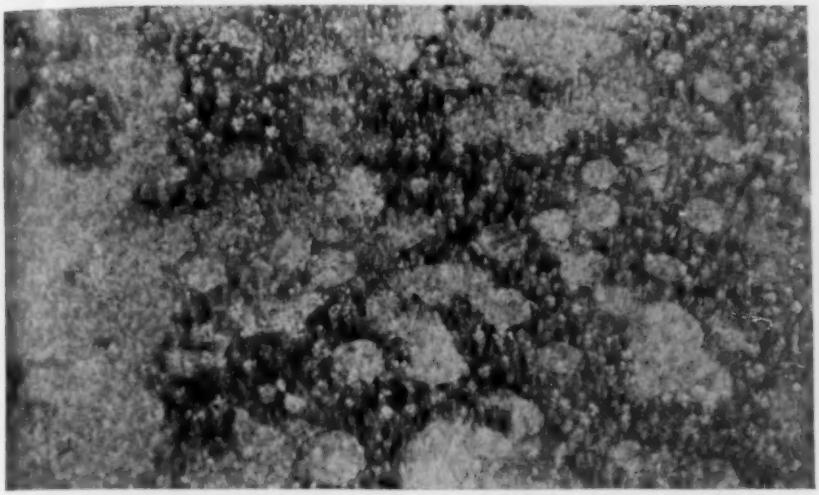

FIG. 6—Mounds in forest on flat terrace partly covered with water (dark). Bassett quadrangle, 33° 21′ N.; 94° 39′ W. Looking northerly from about 2100 feet.

to be precluded by conditions revealed in Figure 6, taken about 30 miles farther along the route.

Here, on a broad, flat terrace of Sulphur River, shallow water was standing, following a period of heavy rains. The camera was pointed steeply downward at an area entirely covered with forest. The darker areas are shallow, standing water; the lighter are dry land. The rounded lighter patches are the mounds, rising as low islands above the water line. Here is clear proof that the phenomena, here at least, are definitely topographic mounds and that they can occur on almost perfectly flat ground. The writer has observed

FIG. 7—Typical mound-dotted landscape; relief 30 to 50 feet. Bassett quadrangle. Center in 33° 21′ N.; 94° 44′ W. Looking northerly from about 2100 feet.

FIG. 8—Typical mound-dotted landscape about 5 miles southeast of New Boston. New Boston quadrangle. Center in 33° 22½′ N.; 94° 22¼′ W. Looking southeasterly from about 2000 feet.

many similar cases from the ground in Winn Parish, La., where mounds 20 to 50 or more feet in diameter and 1 to 2 feet in height are scattered profusely over terraces so flat that in rainy weather water stands upon the surface between the mounds. It does not seem likely that any form of differential erosion could operate on land so flat that rain water stands upon it.

Eastward from the site of Figure 5 the soil mottlings, or mounds, as they will henceforth be called, become more and more numerous and conspicuous. From Sulphur River eastward to Texarkana and beyond the entire landscape is speckled with them (Figs. 7 and 8).

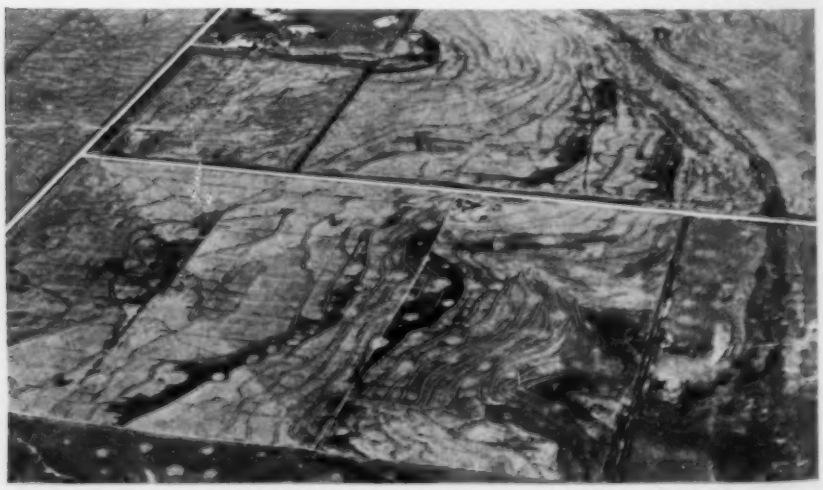

FIG. 9—Mounds in rice fields about 28 miles east of Little Rock, Ark. About 34° 48′ N.; 91° 48′ W. Looking northerly from about 2400 feet. Note how dikes of rice paddies curve around mounds.

They are scattered thickly and almost uniformly over the surface except immediately along the streams. The surface shown in Figures 7 and 8 is broadly rolling, with a relief of 30 to 50 feet. The mounds are perhaps a little more perfectly developed on the broad, flat divides than on the steeper slopes, but the difference is not marked. The soil is red and decidedly sandy.

No definite alignments of the mounds can be made out, but here and there vague suggestions of flowage patterns appear, as, for example, near the upper right corner of the large field in the left foreground of Figure 7 and to the right and below the middle of Figure 8. The flow lines are directed generally down the slopes and may record merely slight modifications of the mounds by sheetwash, though the form suggests that it is rather the *growth* of the mounds that was guided by whatever caused the flow lines.

A distinct tendency can be noted for the mounds to occupy all available space and to interfere mutually so that a polygonal pattern results—polygonal areas of light-red soil with dark soil between. This arrangement strongly suggests competition in the formation of the mounds such as might come about by the expansion of clumps of colonial vegetation. It is also very similar to the pattern revealed in Figure 4 (left), where the soil mottlings seem clearly due to vegetation. Six of the larger mounds measure 102, 128, 111, 85, 105, and 90 feet in diameter—an average of 103 feet.

To permit comparison of the east-Texas mounds with similar mounds in another locality, Figure 9 is introduced. This picture was taken about 6 miles east and a little north of Lonoke and 28 or 29 miles east of Little Rock, Ark., on the airline to Memphis. Such names as "Prairie" and "Prairie Center" in the vicinity suggest that the area may originally have been prairie, which may be significant in view of the fact that this is the only area on the route from Little Rock to Memphis where mounds were noted.

The mounds shown in Figure 9 are somewhat smaller and considerably more widely scattered than those in northeastern Texas. The spacing is rather uniform, but without recognizable pattern. The spacing and distribution seem to rule out definitely the explanation of gullying action urged by Melton. Even differential erosion by sheetwash around clumps of vegetation seems scarcely adequate. Some upbuilding agency is suggested. That the mounds have noticeable topographic relief is indicated by the manner in which the dikes of the rice-paddy fields curve around them.

The presence of mounds in the forested areas such as that around Texarkana is not necessarily incompatible with the suggestion made above that the mounds may be due either directly or indirectly to bunch vegetation in a transition zone between prairie and forest, for the borders of such zones migrate as climatic conditions change.

THE RECLAMATION OF THE PONTINE MARSHES*

Ruth Sterling Frost

SOUTH of Rome along the Appian Way, beyond Velletri and Cisterna, the landscape changes from a wooded hill country to flat plains intersected by canals. On the east this low land is flanked by the majestic and arid Monti Lepini (Volscian Mountains) and Monti Ausoni; on the west from Nettuno to Terracina it borders on the Mediterranean. Formerly it was a place of great desolation and solitude—a few herds of wild-looking cattle or horses, a few miserable straw huts, and vast, silent stretches of water. Today the pestilential marshes exist no longer: they have been turned into productive fields.

This transformation recalls the reclamation of the Roman Campagna, recently described in the *Geographical Review*.[1] Both are part of the great program of comprehensive land improvement, *bonifica integrale*, under way in Italy.[2] On account of the rapidity of its execution and the number and complexity of the obstacles overcome, the accomplishments in the Pontine Marshes are particularly spectacular. On June 26, 1928, the law of the bonifica integrale was approved by the Council of Ministers, and on December 24, 1928, the Mussolini Law, making the necessary financial provisions, was passed by Parliament. The credit of putting the whole scheme on a workable basis is, however, due to Professor Arrigo Serpieri, now undersecretary of the Bonifica Integrale, whose comprehensive scientific plan was embodied in the Serpieri Law of 1924.

When Rome was in its infancy this region to the southeast was inhabited by the mountain-dwelling Volscians, a rich and powerful tribe. Remains of their habitations are found today, and we know the names of some of their cities, founded perhaps a thousand years before Christ—Pometia, Cora, Norba, Setia, Satricum, and Anxur (Terracina) and other strongholds, which were, later, conquered by the Romans. Tradition has it that these plains were of an exceptional fertility and formed part of the granary of Rome. When winter floods subsided there was left an alluvial deposit of such richness that grain could be sown and produced enormous crops without further attention until harvest time, as on the lands overflowed by the Nile.

*I wish to thank Dott. Yandolo, Direttore Generale della Bonifica Integrale, and particularly Dott. Ing. Cav. Uff. Dagoberto Ortensi for their very courteous and kind help, as well as the heads of the Opera Nazionale Combattenti, the Consorzio della Bonifica Piscinara, Ing. Marini of Consorzio della Bonificazione Pontina, Dott. Montanari of the Ministero degli Affari Esteri, and Prof. A. Serpieri, Sottosegretario della Bonifica Integrale, Ministero dell'Agricoltura e delle Foreste.

[1] Roberto Almagià: The Repopulation of the Roman Campagna, *Geogr. Rev.*, Vol. 19, 1929, pp. 529–555.

[2] For steps in the working out of this new conception of reclamation and its present status in the country as a whole see G. Costanzo: Comprehensive Reclamation and Land Improvement in Italy, *Internatl. Rev. of Agric.*, Vol. 25, 1934, pp. E161–174.

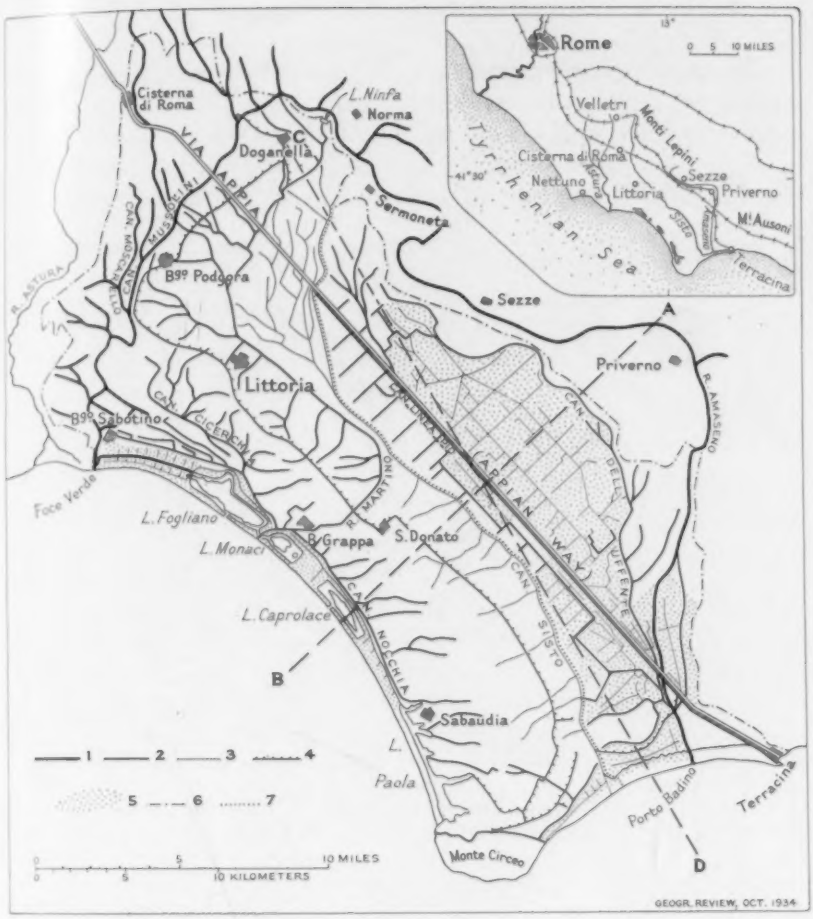

FIG. 1—Map and profiles illustrating the hydraulic problem in the reclamation of the Pontine Marshes. Key to the main map: 1, canals for carrying water from high levels; 2, canals for gravity drainage; 3, canals for pumped drainage; 4, irrigation canals; 5, areas of pumped drainage; 6, boundary of the Agro Pontino; 7, boundary of the Pontino (east) and Piscinara (west) districts. The Quaternary dune formation referred to in the text occupies the greater part of the area between the Sisto and the chain of salt-water lakes and extends as a narrow belt from Monte Circeo to Terracina. Scale of the map, 1 : 400,000. The inset map shows the Agro Pontino in relation to Rome. Scale 1 : 2,500,000. The configuration of the terrain is illustrated in the profiles run from northeast to southwest and northwest to southeast respectively. The areas of pumped drainage are indicated by stipple. The vertical scale is exaggerated 250 times. Map and sections are drawn from official publications of the Consorzio Bonificazione Pontina.

Formation of the marshes, which may be ascribed to natural conditions—a plain of extremely low gradient enclosed by steep, arid mountains with rapid run-off on the one hand and an ancient dune barrier on the other—aided by neglect, wars, and depopulation, led to the ruin of the region. Malaria completed the devastation. The

FIG. 2—"Another wonderful circumstance too—near Circeii are the Pomptine Marshes, formerly the site . . . of four-and-twenty cities." Thus Pliny the Elder in the first century of our era: and only today has the Agro Pontino been restored.

Appian Way, built in 312 B.C., formed part of the route connecting Rome with Athens and the Near East. It is said that malarial fever traveled to the Pontine Marshes by this road. Horace speaks of the fever here in the first century. The fall of the western Roman Empire and the destruction of its civilization by the barbarians caused the abandonment of the region. For 2000 years emperors, kings, popes, and princes vainly essayed its reclamation.

EARLY EFFORTS AND THEIR DIFFICULTIES

Nearly two hundred years before Christ Marcus Cornelius Cethegus made an unsuccessful attempt to drain the marshes. It is interesting to note at how early a date this enterprise was contemplated. No further effort was made until the reigns of Trajan and Nerva, and it must be remembered that these emperors were more interested in maintaining the military efficiency of the Appian Way than in agriculture or sanitation. Large sections of the famous road were inundated and disappeared at various periods. Its construction from the first had been a hindrance to drainage: raised above the general level, it acted as a dike. There are remains of canals that must have

been part of a system of drainage before the Middle Ages. Theodoric, the Gothic king at Ravenna, is known to have undertaken important improvements about the end of the fifth century. But conditions grew worse constantly.

Under Pope Leo X the problem was again attacked in 1515, and

FIG. 3—A plain covered with 6 inches or so of water and a rank growth of tough vegetation is difficult of reclamation. Even after the water was drained off the tangled mass proved obdurate to clearance by machinery, and mountaineers from the Pistoian heights chopped out the roots by hand.

the Canale Portatore, which empties into the sea near Terracina, was built. Seventy years later that energetic pope, Sixtus V, delegated his engineer, Ascanio Fenizzi, to continue the enterprise. He dug the Sisto canal connecting with the river Antico, thus making a large artery following the base of the mountains to collect the run-off of seasonal rainfall and high waters and carry it to the sea. This at least simplified the problem, inasmuch as the annual flood waters were not added to the marsh water from subterranean sources. Some parts of the Pontine Marshes are actually below sea level (see Fig. 1). It must be remembered that in those days there were no pumps run by gasoline or electricity and that the problem of raising great masses of water was serious. The trouble with the Sisto canal as then built was that the gradient was too slight to create enough current. The cost of upkeep was enormous, and as soon as the upkeep of these canals built in the sixteenth century was discontinued a tangle of roots and vegetable matter blocked up the course of the waterways.

Even when deepened and enlarged the Canale Portatore proved inadequate to the task of carrying the waters across the natural dikes to the sea at Terracina. Here an old (Quaternary) dune formation

FIG. 4—A typical composition of forest and swamp in the Selva di Terracina before reclamation.

FIG. 5—Type of primitive dwellings in the Selva di Terracina.

FIG. 6—The castle of Ninfa, a ruined medieval city on the edge of the Marshes, "suffocated by malaria."

FIG. 7.—First fruits of the land in a newly reclaimed area of the Piscinara.

FIG. 8—Type of model farmhouse in the Piscinara for a single family with 10 to 20 hectares of land.

FIG. 9—A view of the city of Littoria, inaugurated December 18, 1932, and now capital of the new province of Agro Pontino.

has from the beginning been a barrier to natural drainage (Fig. 1). There is another difficulty to be borne in mind. The moving soil, the bog, those soft masses of decaying vegetable matter extend from a depth of a few meters to sixty meters. When they are finally dried the level of the ground is considerably lowered and the value of works constructed for drainage is thereby often destroyed.

In the second half of the eighteenth century the Bolognese Gaetano Rappini, working under Pope Pius VI, accomplished the first real results in hydraulic experimentation. The Canale Linea Pio was built parallel to the Appian Way and emptying into the Canale Portatore, which was made more efficient.[3] A series of shorter canals were dug, one Roman mile apart, at right angles to the Canale Linea Pio, and alongside of each canal a highway was made. Thus a large area was opened up, and this has not been altered in the present system. The hydraulic problem had in one sense been solved by Rappini. The defects of his system lay in its incompleteness. Without a comprehensive plan for the entire area—the whole of the Pontine Marshes and also of that outer and somewhat higher zone called the Piscinara—no lasting success could be achieved. One practical error of Rappini's work was that it required a most difficult and expensive upkeep. Another error was the attempt to collect and dispose of all surplus waters in a single channel of insufficient capacity in flood time. The disastrously soft quality of the land over which the smaller canals passed quickly made them useless. As an example I may point out the zone crossed by the Canale dell'Uffente. Here the moving mass of mud and roots was sixty meters deep[4]; the canal became choked in a few months unless constantly dredged. The present policy is to take the canals around the deep morasses where this is feasible and to make them shallower and much broader in section.

The Drainage Problem

The problem confronting the Fascist government in 1923 was fourfold—it embraced hydraulics, agriculture, sanitation, and irrigation. It would be hard to say which part of the problem was the most difficult of solution. To the late Giuseppe Marchi is due the credit of drawing up the first bold and comprehensive plan. This was in 1923.

The Institute of Military Geography carried out an important step by mapping an area of 760 square kilometers on a scale of 1 : 5000, giving the elevation of every half meter.[5] Thus many misconceptions

[3] See the reproduction of a map of 1791 in Mario Baratta: Paludi Pontine, *L'Universo*, Vol. 10, 1929, pp. 245–279, map opp. p. 248.

[4] Dagoberto Ostensi: La grande bonifica fascista dell' Agro Pontino, *L'Ingegnere*, Vol. 6, Milan, 1932, pp. 89–93.

[5] See Corrado Bellandi: Lavori topografici per la bonifica pontina, *L'Universo*, Vol. 14, 1933, pp. 677–685, map opp. p. 680.

FIG. 10

FIG. 11

FIG. 12

FIG. 10—New bridge over the Mussolini Canal where it crosses the ancient but still used Appian Way.

FIG. 11—Completed canalization and enlargement of the river Sisto.

FIG. 12—Type of farmhouse on reclaimed land now under cultivation.

were clarified and errors corrected. This was in 1926 and 1927. It was the basis for a profound study of the sources of the water that overflowed the region—whether due to rainfall or to seasonal torrents from the mountains, or whether from subterranean sources by springs or seepage—and thereby unsuspected conditions were revealed. As

FIG. 13—Sabaudia, the new city inaugurated April 15, 1934.

a result the watershed drainage of the entire length of mountain region from Fosso di Sermoneta encircling the Piscinara to the west (185,328 acres) is now collected in a system emptying by the Canale Moscarello into the sea at Foce Verde. By this operation all of the Piscinara is freed from the danger of flood waters. The Pontine region has been drained by opening a canal from the foot of Sezze to the north of Priverno, connecting with the river Amaseno, which in turn links with the higher-level canal of the Pontine and is emptied at Porto Badino south of Terracina. These two canals encircle the whole marsh region to the west and the north and northeast. The average volume of water emptied at Foce Verde alone is 20 cubic meters a second.

The hydraulic work for the reclamation of the Piscinara is distinct from that of the Pontine Marshes. The waters are classified according to their levels. Those below sea level are pumped. The collecting canal for waters originating at a medium level begins at the small lake at Ninfa, and these are carried by way of Rio Martino out to sea between the lakes of Fogliano and Monaci. Two subsidiary collecting canals, the Cicerchia and the Nocchia, draining the seaward slope of the Quaternary dune, empty into Rio Martino just before it reaches its destination. Canals collecting the lowest levels of water

are pumped into the Sisto canal, which, according to the project, will have its own discharge into the sea.

There is also the matter of the large salt-water lakes that lie between the sandy shore and the Quaternary dune. As these lagoons were too large to remove, the shores were filled up to a certain computed level and banked to such an extent that percolation even in high tides and storms was guarded against. The banking of the shores proved a serious problem because of the bog foundation. But a virtue has been made of necessity. Once the shores of these lakes were reënforced enough to prevent all danger of inundation of the surrounding lands, a fishing industry was started, which has proved most successful. The lake of Fogliano alone supplies 500 to 800 kilos a year of the finest fish, a large part of which is marketed in Rome. It is a part of the problem to keep the lakes replenished with sea water, for if allowed to fill with fresh water and become stagnant they would afford a breeding place for malaria mosquitoes. For this reason the entrance to the sea must be constantly dredged. The task of ridding the whole district of mosquitoes and flies has been most effectual.[6]

Agriculture and Settlement

The work of putting the land into shape for agricultural purposes and for settlement was carried out by the Opera Nazionale per i Combattenti (National Ex-Service-Men's Foundation) and the Consorzio dell'Agro Pontino and the Consorzio della Piscinara, associations of farmers and landowners.

Many of the original landowners were lax and, in some cases, even after the expensive government reclamation had been put into effect were willing to use the land for pasturage or even for shooting preserves. Here authority stepped in and expropriated the land, turning it over to the proper agencies to be made into farms for intensive cultivation and for home makers. Other great landowners, among them Don Gelasio Caetani,[7] have given evidence of the highest citizenship and public spirit in land reclamation. The Agricultural College at Sermoneta and a large number of model farms are the notable results of their initiative.

The Consorzio dell'Agro Pontino has employed and is still employing all the resources of modern machinery—armies of tractors,

[6] Since this article was received an account of the health measures undertaken in the region has appeared (A. Ilvento: The Reclamation of the Pontine Marshes, *Quart. Bull. Health Organization*, League of Nations, Geneva, Vol. 3, 1934, pp. 157–201). Professor Ilvento gives some striking figures. Thus an attempt to introduce rice cultivation in the marshes before bonification resulted in an excellent harvest but 100 per cent malaria cases among the specialist laborers brought in from the Po Valley. On the other hand in Sermoneta, on the edge of the marshes, where formerly 80 per cent of the population suffered splenomegaly, there now are practically no cases of malaria.—Edit. Note.

[7] See his articles on the Pontine Marshes in the *National Geographic Magazine*, Vol. 45, 1924, pp. 357–374, and Vol. 66, 1934, pp. 200–202 and 211–217.

and plows, dredges, and engines. The consortia have placed villages where important roads converge, and in each village or small town are a church, a school, a free dispensary, places of recreation and study, a post office, a police station, a district trained nurse, and an infirmary. Electricity, the radio, pure drinking water, water for irrigation where needed, and model farmhouses and barns are a part of the equipment.

Littoria is the largest city of the Agro Pontino. It was inaugurated by Mussolini, December 18, 1932. The city had been begun in June of that year: it was complete, with post office, city hall, railway station, clubhouse and theater, and many houses, in October; only the cathedral was not finished, but civic life had already been established. It was planned for a population of about 20,000 inhabitants. It looked to me when I saw it in October, 1932, like any California town that had been in existence for about ten years, only the buildings were more imposing. From the streets of this new city can be seen green fields extending in every direction, dotted with cement farmhouses and barns, the latter painted a pale blue as flies are said to dislike that color!

The city of Sabaudia situated near the Lago di Paola has been built still more recently: it was inaugurated by King Victor Emanuele on April 15 of this year.

The Commission for Internal Emigration and Colonization has had the task of deciding on the colonists to be settled in the new region. They are drawn from the densely populated farming areas of northern Italy where there is not enough land to go round. The settler receives a house and barn and all equipment, including farm animals. He pays for this in small annual payments over a long period of years. Certain expert farmers and livestock breeders have been established in each new district as a practical demonstration to new settlers, and in addition there is a technical adviser with two agents under him for every 100 hectares of land.

The accomplishment of the Ex-Service-Men's Foundation is worthy of attention. The first stage, the reclamation of 25,250 acres with farms, towns, and population, begun on February 14, 1931, was completed December 18, 1932, with the inauguration of Littoria. This comprised the area around Littoria. The second stage, the conversion of 35,250 acres of land to profitable use, with farms, roads, cities, railroad connections, etc., was completed December 12, 1933. This extended the work east, west, and south of the Littoria district. The third stage, the preparation of 42,500 acres more, was begun on April 18, 1934, and is still to be completed. This is mainly the area in the Selva di Terracina. The Foundation summarizes its accomplishment in the last two years as follows: 2447 farmhouses (cement) and 416 kilometers of excellent roads built; 1756 kilometers of canals and

9,800,000 meters of drainage ditches dug; 50,000 acres of land cleared of stumps; 103,000 acres of land plowed—employment representing in total 6,483,000 workmen's days. Today 1360 families are living on this land and farming it under ideal conditions. These figures refer to the part of the Piscinara given over to the Ex-Service-Men's Foundation.

Thus not only has this area become a vast field of intensive cultivation, whose products will help to reduce the country's importation of grain and other foodstuffs, but it is no less important from a sociological point of view. In 1932, in the region around Littoria, 20,000 people were already settled in new homes, and there has been a great increase in the last two years. As far as possible the policy is for permanency. Transient labor is considered less valuable for the people and the soil. The state has expended more than 700,000,000 lire, and from private sources another 300,000,000 lire has been spent in this development. One of its most striking features is that every part of the undertaking has been completed in less time than originally planned. Indeed, the transformation seems little short of miraculous. Everywhere one is struck by the beautiful order and the Utopian quality of the work.

IRRIGATION IN A DRY-FARMING REGION

THE GREENFIELDS DIVISION OF THE SUN RIVER PROJECT, MONTANA*

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University of Minnesota

THE placing of an elaborate irrigation system in a semiarid region already homesteaded by dry-land farmers in the American fashion creates a special problem in the study of pioneer-belt settlement. It is a special problem because of the tendency, on the one hand, to overestimate irrigation as an agency of change and, on the other, to minimize the vitality of a well established dry-land culture.

We are inclined to assign to irrigation well-nigh magical powers of regional transformation. For illustrations we may turn to the civilizations of the Mediterranean lands; perhaps also, and with equal propriety, to certain colonization and government-supported schemes of undoubted success in the arid western United States, momentarily forgetting that in such instances irrigation and settlement proceeded simultaneously. Regions only semiarid, however, are likely to present a different situation. Many a part of the western Great Plains, for example, acquired irrigation works long after the land had become occupied under quite another system. In such localities the bumper wheat yields of occasional seasons of ample rainfall are well remembered, there are strong traditions urging large fields planted to crops that may be "made" with power machinery, and there are equally strong prejudices against irrigation except possibly as an adjunct to general ranching. By many irrigation is unwanted; to the greater number it is an unknown practice whose adoption may necessitate costly changes in accustomed procedures. The result is that the principal features of the established dry-land culture persist unduly under the new system: irrigation belatedly "comes of age."

An illustration is afforded by the largest division of the Sun River Irrigation Project, a government-supported scheme in northwestern Montana.

The Sun River Irrigation Project

This project, as its name suggests, is watered by the Sun River, one of the principal mountain tributaries of the Missouri, which it joins at Great Falls, Montana. Fed by headstreams draining more than a thousand square miles of the humid, forest-clad Lewis Range

*The fieldwork upon which this study is based was made possible by a fund granted for that purpose by the Rockefeller Foundation through the University of Minnesota.

of the northern Rockies, the Sun River flows in a wide trench 200 feet and more in depth across the 50-mile piedmont slope to Great Falls. The oldest division of the Sun River Project, called the Fort Shaw Division, includes the flood lands and low terraces bordering the river (Fig. 1). Shelving away from the steep banks of the Sun and the other entrenched rivers of the piedmont, the long, smooth slopes of the

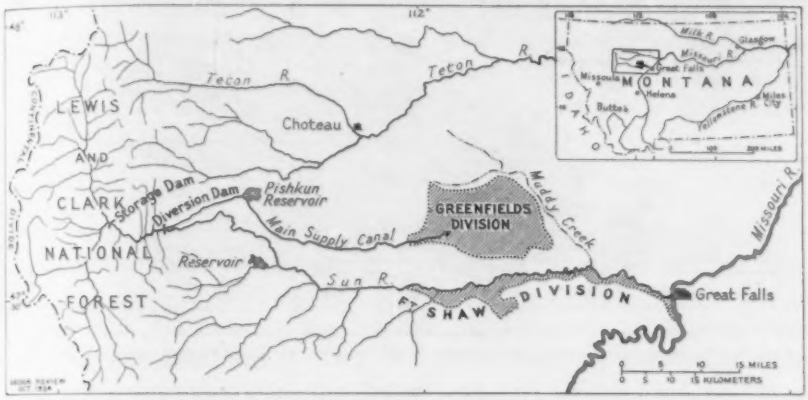

FIG. 1—General map of the Sun River Irrigation Project, Montana. Scale 1 : 1,500,000.

Great Plains rise by successive levels to the base of the distant mountains. These elevated, flattish, interstream platforms, remnants of the original surface, are locally called "benches," to some of which proper names have become affixed.[1] The Greenfields Bench, typical of the higher surfaces of the piedmont, lying north of Sun River and about midway between Great Falls and the mountain border, is the main division of the Sun River Project.

THE GREENFIELDS BENCH

Roughly rectangular in shape, measuring some twenty miles east and west and slightly less than ten north and south, the Greenfields Bench is separated by steep slopes from the surrounding lower lands and other parts of the project. Most clearly marked is the southern boundary, an escarpment towering 200 feet above the wide valley of the Sun River (Fig. 1). The maximum elevation of 4000 feet is reached here. From this high edge the surface slopes gently away from the river toward the north and northeast. At the north edge, where the elevation is 300 feet lower, the bench is cut by a valley, in the bottom of which Muddy Creek, an underfit stream, now meanders (Fig. 2). On the east the surface is scored by a number of long coulees. On the west is an enclosed basin, in a part of which the alkaline Freeze-out (or Greenfields) Lake is located. Fortunately for irrigation,

[1] On the physiography of this region see "Physiography and Glacial Geology of Eastern Montana and Adjacent Regions," noted elsewhere in this number of the *Geographical Review*.

however, in the southwest the surface is connected with the higher lands rising to the base of the Lewis Range, and here the main supply canal for the lateral system enters the bench. The main canal, which traces a winding course along the high southern margin, forks into subsidiary canals following two curving strips of steeply sloping land that divide the surface into three distinct levels. These features are recognized as ancient terraces, which may be referred to simply as the

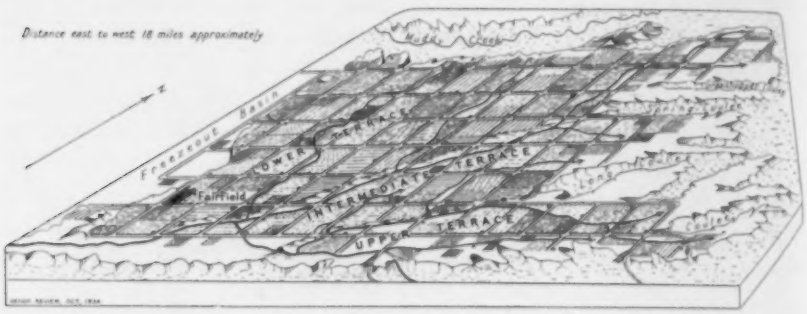

FIG. 2—Diagrammatic view of the Greenfields unit of the Sun River Project (compare Fig. 3).

lower, intermediate, and upper terraces. Now high above any stream or river, they were presumably etched out in preglacial or glacial times—a reasonable assumption in view of the earlier studies by Calhoun and Fisher,[2] which showed this region to have been marginal to a wasting ice sheet. In an ingenious manner the canals course along the upper margins of the terrace scarps, thus providing by gravity flow for the irrigation of the level immediately below.

Although the choice of the name appears to have been accidental, "Greenfields" aptly describes the summer-time appearance of the three terraces atop the bench. A surface exceptionally favorable for irrigation has but few small unwatered areas above the threading canals. The summer landscape is, therefore, mainly a patchwork of shades of green, the deep hues of the heavily irrigated alfalfa and clover hayfields dotted with conspicuous haystacks, the lighter, early-season greens of the ubiquitous small grains, and the many shades of irrigable if not irrigated pastures varying with the degree of their irrigation. Less than three-fourths of the farms possess farmhouses. These are placed with almost studied regularity along the straight section-line roads, and a few of them are rendered more conspicuous by growths of young cottonwoods, the bench being still practically treeless. In the southwest amid enclosing fields is the village of Fairfield with 150 inhabitants, the only aggregation of dwellings in the entire hundred square miles of occupied land. There, grouped in loose association within a small part of a quarter section, are some

[2] C. A. Fisher: Geology and Water Resources of the Great Falls Region, Montana, *U. S. Geol. Survey Water-Supply Paper 221*, 1909, especially pp. 24–25.

fifty houses, a dozen stores strung along the main Glacier Park Highway, and, towering above all and first to be seen from afar, three grain elevators alongside the tracks of a branch railroad, which now carries a three-car train four days a week. Clustered in a separate part of the town are the trim buildings of the Reclamation Service, so placed originally to be near the upper end of the canal system. Finally, it may be observed from the diagram, the occupied area does not exactly coincide with the natural limits of the bench. In the eastern part, at present beyond the reach of the life-giving canals, green fields abruptly end and the steppe there retains its native dun-colored appearance except in early summer.

Cultural Features and Land Uses

The roads, the lateral system, the open drainage ditches, the fence lines, the farm and village homes, and the two railroad lines may be regarded as the more or less unchanging features of the unit. The pattern that results from the first four provides an interesting study in degrees of artificiality. On the one extreme are the roads and fence lines, determined by the original rectilinear survey, and on the other is the lateral system, which reflects the smallest details of surface configuration. The unsightly drainage ditches, occasionally paralleling roads and fence lines but usually conforming more closely to the lay of the land, reveal both influences. Drainage ditches and laterals, though functionally opposite, are nevertheless closely identified with each other. The excess water of both ultimately flows into Muddy Creek, but before arriving there the water may be transferred several times from one to the other. In this manner the duty of the irrigation water is greatly increased.

Irrigated pastures are widely dispersed through the bench, hardly a farm being without a fenced pasture, often too small to be shown on the map, Figure 3. Commonly pasture land in any quantity denotes areas of inferior soils or inferior irrigability or both, as witness the considerable areas on the steep slopes of the terrace rises, strips below canals damaged by seepage from them, and areas where a rising layer of hardpan causes a poorly drained surface with consequent danger of alkali accumulation. These various surfaces may still support a thick, weedless grass cover, or "sod," as the local residents prefer to call it.

However, additional pasture must be sought for the 1200 dairy cows, 2500 beef cattle, and 12,000 sheep, with the result that non-irrigable land both without and within the project is pressed into use. The steppe lands rising above the laterals and not used for dry farming, the rough, steep slopes of the coulees, and the flat land beyond the eastern reach of the present lateral system are available to graziers.

FIG. 3.—Map showing land utilization and water resources in the Greenfields unit (1933). Key: 1, canals and laterals; 2, open drainage ditches; 3, wheat; 4, barley and oats; 5, alfalfa and clover; 6, other crops (corn, mustard, flax, potatoes, gardens); 7, fallow and idle; 8, pasture; 9, seepage and alkali; 10, largely grazing; 11, steep or rough land; 12, land above laterals used for dry farming; 13, land above laterals used for grazing; 14, fences; 15, other field boundaries; 16, farmsteads; 17, schools; 18, churches.

But this additional pasture is still insufficient even in the aggregate, owing in part to overgrazing in the past. Consequently a fenced "community pasture" for use by project stockmen is maintained some twenty miles to the west, and elsewhere through the high steppe shepherds with their sheep wagons are occasionally to be seen directing the summer feeding of roving bands of sheep, which will be returned to the irrigated land for winter feeding.

The winter feeding of such numbers of livestock necessitates the large area of tame hay, the crop largely responsible for the deep-green color that is the first as well as the most lasting impression gained upon viewing the project.

Wheat, however, is the characteristic crop of the Greenfields Division. Nearly one-half of the cropped and irrigated land was used for this crop in 1933. However, the proportion of land occupied by wheat is decreasing—in 1925 it was 70 per cent of the cultivated land for Greenfields and Big Coulee—while alfalfa is yearly on the increase. The predominance of wheat would not be so surprising if its production were attended with any notable success, but such is not the case. Low yields to the acre are uniformly recorded: in 1924 the average production on 15,421 acres under irrigation was 10.2 bushels an acre, and in more recent years the average production has been consistently under 15 bushels an irrigated acre. This low production cannot be assigned to natural causes, inasmuch as the water supply is always ample, with a more than adequate duty of two acre-feet a season, and the soils are reasonably fertile. It may be briefly stated that the soils[3] are the light-brown loams normal to the steppe climate and are underlain at ten inches by a lime-carbonate layer. Lenses of preglacial gravels occur at various horizons, but the surface soils are remarkably uniform, differing only in the proportion of silt. This uniformity is reflected in the distribution of crops on the bench.

The great extent of the grain crops in this irrigated region contrasts strangely with the limited area of intensively tilled land. Nearly every farm home has a near-by garden, the credit for which is largely due to an educational program recently carried on by the county agent. Commercial potato, sugar-beet, and even corn fields are, however, rare, although they are widely distributed in the Fort Shaw Division. The most unusual crop is mustard, but it is not intensively or even carefully tilled, nor is its total area large. The absence of such land uses may be explained in part, but certainly not wholly, by the lack of a consuming center within the region. Fairfield, established with high hopes in 1916, soon reached a stage of arrested growth. It provides a few stores, of use to some of the local residents as well as to occasional tourists, but its services to the region are distinctly cir-

FIG. 3.—Map showing land utilization and water resources in the Greenfields unit (1933). Key: 1, canals and laterals; 2, open drainage ditches; 3, wheat; 4, barley and oats; 5, alfalfa and clover; 6, other crops (corn, mustard, flax, potatoes, gardens); 7, fallow and idle; 8, pasture; 9, seepage and alkali; 10, largely grazing; 11, steep or rough land; 12, land above laterals used for dry farming; 13, land above laterals used for grazing; 14, fences; 15, other field boundaries; 16, farmsteads; 17, schools; 18, churches.

[3] The soils have been carefully studied and mapped by William DeYoung in his "Soil Survey of the Sun River Irrigation Project," *Univ. of Montana Agric. Exper. Sta. Bull. No. 207*, Bozeman, 1927.

cumscribed. For example, it contains no equipment for processing dairy products, which are therefore sent raw to Great Falls by train and truck.

Still other features indicate that the original culture has not as yet been greatly transformed by irrigation. Of 430 farms, 17 measure 40 acres; 175, 80 acres; 17, 120 acres; and 215 are quarter sections. The average farm size is undoubtedly too large in view of the high proportion of irrigable land. Indirectly it suggests that the region is underpopulated. Including the village of Fairfield, the population is nearly one thousand, giving a density of about ten to the square mile. The housing of farm and village folk is, on the average, quite mediocre and in general appearance and appointments differs little from the typical dry-land farmsteads of the more prosperous parts of western Montana. In a number of instances, in fact, the houses have been moved into the project from the surrounding partially abandoned, unirrigated regions.

Settlement Preceding Irrigation

Before 1902 what is now known as the Greenfields Bench was a part of the Montana cattle range, undifferentiated from its surroundings except by name and by a certain prestige as an excellent bit of open range. In those days it was called Freezeout Bench, so named after the unhappy experience of a party of cowboys during the round-up of 1884. Pioneers state that the grass atop the bench grew to the knees of the horses they rode and, under the influence of winds and occasional chinooks, was dependably free from snow in winter. The first settlers moved in from Choteau, a town early established in the irrigated area along the near-by Teton River, in 1902, and by the next year 25 families were settled on the bench, marking the end of the open range.

These people were somewhat familiar with irrigation—it had been resorted to in the Sun River lowlands since 1867—and they were quick to appreciate the favorable surface. In that year Fort Shaw, one of a series of frontier fortresses designed to protect the stage line from Fort Benton to Helena, was established near the customary river crossing. Irrigation there had proved relatively easy, but delivery of water to the elevated bench presented difficulties. There followed many years of frustrated attempts, of which the venture of the Kilraven Company is typical. A diversion point high in the Sun River was selected, and seven miles of shallow ditch were roughed out, only to be abandoned at that point. Planned as a high-line contour ditch, its necessary length would have been 40 miles, with the probability that the water would have disappeared before reaching its destination.

In 1892 the Fort Shaw post was abandoned and its reservation

reverted to the public domain. This provided a large body of unappropriated land in a proved irrigable region, setting the stage, so to speak, for the entrance of the newly created Reclamation Service. Simultaneously with the opening of the Fort Shaw Division in 1908 the Freezeout (Greenfields) Bench was incorporated in the plans for the same project. But nearly twenty years were to elapse before any considerable part was "under the ditch." Before this could be accomplished large-scale engineering schemes were necessary—the construction of the huge Gibson Dam for storage high in the mountain fastnesses; the diversion dam below to direct water to the Pishkun Reservoir and thence to the long main supply canal; the lateral system, with its innumerable flumes, chutes, culverts, "drops," "weirs," "checks," and "turnouts," skillfully designed to include the maximum area of irrigable land. Later, and in consequence of irrigation, the drainage ditches were excavated. Begun in 1921, ditches are still in the process of construction.

During the quarter of a century intervening between the failure of the Kilraven Company and the successful delivery of water by the Reclamation Service a considerable part of the bench had been homesteaded under desert entries. The group was, and still is, remarkably homogeneous, being mainly Norwegian or of that descent, but the region was not settled by colonies. Most of the settlers were unfamiliar with irrigation. They moved in from the dry lands of the Dakotas and eastern Montana, particularly in 1910. They remained dry-landers and met with some degree of success, especially in 1915–1916, which were years of ample rainfall when wheat yielded abundantly. It is recorded that there was much agitation followed by public demonstrations to prevent irrigation of this allegedly excellent dry-land and range country. Even after 1920, when irrigation had become an actual possibility for a part of the bench, settlers continued to come from the dry lands, bringing their traditions, equipment, and crops.

Circumstances Tending to Perpetuate Dry Farming

Certain conditions tend to encourage the continuance of familiar practices, even though there is now available a well engineered and efficiently managed irrigation system. The large area of the farm units, the availability of planting and harvesting machinery useful only in large fields, convenient facilities for marketing the grain, the small initial investment (as compared, for example, with stock raising), the desire to farm on a "big scale"—all tend to preserve the extensive methods of cultivation.

Rainfall conditions also play a part. Because of the peculiarities of the rainfall of the Great Plains there is a tendency to depend,

usually unwisely, on the chance of copious spring rains, which do occasionally, and perhaps unfortunately, occur. An opportune rain may save much labor of irrigation, but if the rain does not occur the season may by that time have advanced too far for the proper preparation of the ground. The "Annual Project History" for 1924 remarks:

> The weather conditions in this part of the country have an important influence on irrigation, for with the class of farmers now on the project there is still a tendency to rely more on rainfall than on irrigation water in the production of crops. The season of 1923 was one of excessive rainfall and good crops were produced without using water from the canal system. It was hoped by many farmers that similar conditions would prevail in 1924. . . . The month of May started in warm and dry. The ground was so dry that many crops would not germinate and it became necessary to use water to get them started. On the 6th. of June it began to rain, and within a few days practically all deliveries of water on the project were discontinued. The rainfall for June was a little less than the average quantity. . . . The total for the season was 7.75 inches as compared to the average of approximately 11 inches. On many farms, particularly on the Greenfields Division, very poor crops were produced simply for the reason that the land owners were not willing to avail themselves of the water that was flowing in the ditches throughout the season.

The above quotation was written ten years ago. During the past decade the art of irrigation has become more familiar, but, interestingly enough, the manager writes in his "Project History" for 1931:

> This land [the Greenfields Division] was very fertile, and when well supplied with moisture either by rainfall or by irrigation, excellent crops of wheat have been produced. As a result the farmers have followed this line of farming and have been very slow to change to a more diversified type.

Unless the rate of change is thrown into higher gear by influences at present unforeseen, another quarter of a century will have elapsed before the Greenfields Division will have taken on the measure of maturity that now characterizes the older Fort Shaw Division, to which it is potentially superior.

AN ATTEMPT TO CROSS-DATE TREES IN DROWNED FORESTS

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FIG. 1—Map showing location of the drowned forests discussed.

Drowned forests on the seacoast of New England and Nova Scotia have long been objects of scientific curiosity. Well preserved stumps and logs of familiar modern species seemed to prove recent sinking of the land.[1] Because the drowned forests occurred in a region known to have been strongly upwarped during the removal of the last ice sheet, the subsequent sinking was thought to be a reverse movement, possibly the delayed flattening of what had been a peripheral bulge around the depressed ice-covered area.[2] As evidences of submergence were found more generally around the world, and as careful estimates confirmed the opinion that sea level itself had swung up and down during successive glacial and inter-glacial epochs, the drowned forests came to be interpreted as records of eustatic change.[3] Finally, the recognition of climatic changes during the last five or ten thousand years, attended in all probability by thickening and thinning of the Antarctic ice sheet, has suggested more recent oscillations of sea level. Both the nature and the date of submergence of the forests are more complex problems than first supposed.

Is Submergence Still in Progress?

From the beginning the drowned forests have inspired the view that the submergence, whatever its cause, is still going on. Particular significance has been attached to the fact that sunken forests commonly underlie salt-marsh deposits, whose peaty structure, often twenty feet thick, registers a slow upbuilding of the marsh surface by plants that can grow only close to high-tide level and must have maintained the surface of the deposit at that level continuously from the time when salt marsh first invaded the dying forest up to the

[1] J. W. Dawson: On a Modern Submerged Forest at Fort Lawrence, Nova Scotia, *Quart. Journ. Geol Soc. of London*, Vol. 11, 1855, pp. 119–122, and *Amer. Journ. of Sci.*, Ser. 2, Vol. 21, 1856, pp. 440–442.

[2] R. A. Daly: Oscillations of Level in the Belts Peripheral to the Pleistocene Ice-Caps, *Bull. Geol. Soc. of America*, Vol. 31, 1920, pp. 303–318.

[3] W. B. Wright: The Quaternary Ice Age, London, 1914, p. 417; R. A. Daly: Swinging Sealevel of the Ice Age, *Bull. Geol. Soc. of America*, Vol. 40, 1929, pp. 721–734.

present day.[4] But this botanical evidence of modern coastal instability can be otherwise interpreted.[5]

In England, where good vertical sections of recent deposits have been exposed in harbor improvement on the Thames and other estuaries, submerged forest beds occur at two distinct horizons; they extend widely over the Dogger Bank on the floor of the North Sea, down to at least 60 feet.[6] Whether the successive drownings there are local manifestations of world-wide eustatic changes in sea level or whether they mark crustal downwarpings of the area peripheral to the last European ice sheet is uncertain. In any case, it is significant that there is definite evidence in England of relative stability of land and sea during the last 2000 years.[7] The case in eastern North America resembles that in northern Europe. Upwarping of the coast followed closely the removal of the last ice sheet; submergence came later, perhaps repeatedly, partly from eustatic changes and partly from crustal movements. While the final five to fifteen feet of submergence in New England is known to have occurred since Indian occupation of the coast,[8] there are three or four independent lines of evidence to support the view that this coast, like that of England, has neither risen nor fallen in relation to the sea for several centuries.[9] Curiously discordant results from recent analyses of tide-gauge records in this same region do not seem seriously to impair the argument.[10]

Though an ever increasing variety of evidence for and against modern stability has been assembled during the last twenty-five years, no one seems to have attempted more thorough study of the forests themselves. So in 1931 we proposed to collect sections of trees from drowned forests at different places on the coast between Cape Cod and the Bay of Fundy and to try by measurement of their growth rings to cross-date them and thus to work out the rate of rise

[4] B. F. Mudge: The Salt Marsh Formations of Lynn, *Proc. Essex Inst.*, Vol. 2, 1856–1860, Salem, 1862, pp. 117–119; C. A. Davis: Salt Marsh Formation near Boston and Its Geological Significance, *Econ. Geol.*, Vol. 5, 1910, pp. 623–639.

[5] D. W. Johnson: Botanical Evidence of Coastal Subsidence, *Science*, Vol. 33 (N.S.), 1911, pp. 300–302; *idem:* Botanical Phenomena and the Problem of Recent Coastal Subsidence, *Botan. Gazette*, Vol. 56, 1913, pp. 449–468.

[6] Clement Reid: Submerged Forests, Cambridge and New York, 1913.

[7] *Ibid.*, pp. 60–61.

[8] E. B. Delabarre: A Possible Pre-Algonkian Culture in Southeastern Massachusetts, *Amer. Anthropologist*, Vol. 27, 1925, pp. 359–369; *idem:* A Prehistoric Skeleton from Grassy Island, *ibid.*, Vol. 30, 1928, pp. 476–480; C. C. Willoughby: An Ancient Indian Fish-Weir, *ibid.*, Vol. 29, 1927, pp. 105–108; H. W. Shimer: Post-glacial History of Boston, *Proc. Amer. Acad. of Arts and Sci.*, Vol. 53, 1918, pp. 439–463.

[9] D. W. Johnson and W. G. Reed, Jr.: The Form of Nantasket Beach, *Journ. of Geol.*, Vol. 18, 1910, pp. 162–189; J. W. Goldthwait: Physiography of Nova Scotia, *Canada Geol. Survey Memoir 140*, 1924, pp. 170–173; R. P. Goldthwait: Damariscotta Shell Heaps and Coastal Stability, *Proc. Geol. Soc. of America for 1933*, 1934, pp. 451–452 (abstract).

[10] J. R. Freeman: Subsidence of Land and Harbor Bottom, Appx. 20 to Rept. of Committee on Charles River Dam (Boston), State of Mass., 1903, pp. 529–572; Douglas Johnson: Studies of Mean Sea-Level, *Bull. Natl. Research Council No. 70*, 1929; B. Gutenberg: Tilting Due to Glacial Melting, *Journ. of Geol.*, Vol. 41 1933, pp. 449–467.

of sea level that had killed first one tree and then another. Funds were provided by the Carnegie Institution of Washington and the American Geographical Society of New York.

Selection of Forests

In selecting forests for study we sought to avoid all cases where the trees might have been killed in consequence of some purely local change in configuration of the shore, such as the flooding of a lagoon to a new high watermark or the undercutting or burial of a soft, compressible peat bog by encroachment of the sea at its outer margin. Actual cases like these are well known from direct observation, and we may assume that they were all too common in prehistoric time.[11] Obviously, too, we must find forests in which trees of considerable age and preferably of one species grew in fair abundance and not so far apart but that slow rise of the sea from one tree to another came well within the lifetime of successive individuals. The stumps must not have been worn down too close to the roots, where ring widths are abnormal, and the bark should remain outside the ring that marks the last year of life of the tree. The wood must of course be in fair state of preservation. These difficulties and others less serious led us to discard most of the numerous forest sites previously reported and visited and to concentrate attention on five only. It was our hope that accurate mapping and leveling of these, accompanied by careful sectioning, measuring, and graphing of our material, might yield positive results. The forests selected were: Fort Lawrence, at the head of the Bay of Fundy, N. S.; Grand Pré, on the northeast arm of the Bay of Fundy; Scarboro, near Portland, Me.; Odiorne Point, near Portsmouth, N. H.; and Provincetown, on Cape Cod, Mass. Their locations are shown in Figure 1, and short descriptions follow. Each forest site was visited repeatedly at favorable tides. Copies of all maps and graphs are on file at the American Geographical Society for future reference. The present paper is a summary.

Description of the Forest Sites: Fort Lawrence

Because this is one of the first drowned forests reported in America and the largest known,[12] we mapped it in detail and made every attempt to get good sections of the trees. The forest lies on a slope of firm, stony ground exposed at low tide. Slightly more than half of the stumps occur near mid-tide level, with a second group scattered

[11] Johnson, Botanical Phenomena.

[12] See Dawson, *op. cit.; idem:* Acadian Geology, 2nd edit., London, 1868, pp. 28–32; Robert Chalmers: Report on the Surface Geology of Eastern New Brunswick, North-western Nova Scotia, and a Portion of Prince Edward Island, *Canada Geol. Survey Ann. Rept.*, Vol. 7 (N.S.), 1894, Ottawa, 1896, pp. 1 M–149 M, reference on pp. 125 M–133 M; Douglas Johnson: The New England-Acadian Shoreline, New York and London, 1925, pp. 575–580; J. W. Goldthwait, *op. cit.*, pp. 155–159

around a point about five feet lower and 500 feet nearer low water-mark. In these two areas we mapped a few fallen trees and more than 200 stumps, some of which had been trees with diameters of two feet or more, while many, especially of those in the lower group, were only a few inches through. The density of stand we found normal except in the space between the two groups, where there were only a few scattered stumps. At its upper edge the forest disappears abruptly under a layer of mud. As the surface of this mud rises more steeply than the old forest floor, it is probable that much of the original forest lies buried under it. The channel of the La Planche River limits the forest on the south, while on the north there are a few scattered remains of large stumps and root systems beyond the limits of our map.

It was a disappointment to find that of the many stumps seen and mapped only 24 were sufficiently sound and undamaged by erosion to furnish useful sections. Another surprise came when the 24 trees in this collection were identified as representatives of 8 different species. Most of the trees sampled in the lower part of the tract were fir balsam, while those of the inshore and higher area were either pine or hemlock. This suggests a possible change of climate during the advance of the sea from lower to higher levels. Beech, maple, and spruce were represented by only four sections.

The Grand Pré Site

This forest, which furnished us with our best material, is exposed on the freshly scoured floor of a broad tidal channel called "the Guzzle." It runs in a northeast-southwest direction between Boot Island and Long Island in the town of Grand Pré. On both sides the salt marsh is being undercut by wave and current action, revealing underlying stumps rooted in firm ground. They occur in groups from a point about 20 yards out from the marsh cliff and some 17 feet below high water down to a point half a mile beyond the first and 14 feet lower. Both stumps and rooted logs rest where they grew, in a layer of fibrous humus 3 to 8 inches thick. Beneath this dark layer is a gray clay, probably the Champlain marine deposit, 20 to 24 inches thick, and below it is the stony ground moraine of the last glaciation. Shifting of sediment with ebb and flow of tides exposes or covers the stumps day after day. In winter sea ice, moving and grounding, wears down the tops of stumps and the upper sides of fallen logs. Each season a new area of forest is uncovered.

According to eyewitnesses who have lived here since boyhood, the Guzzle, 50 years ago, was a shallow depression only 15 or 20 feet wide at Boot Island. Wagons loaded with hay were driven across it at all but high tides over a fill of poles, where now it is 300 to 400

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Stumps and logs exposed near the face of the eroded marsh cliff, Grand Pré, N. S. August, 1931.

FIG. 3—Stumps beside "the Guzzle," Grand Pré, N. S. Boot Island in right background. August, 1931.

FIG. 4—Junction of living and drowned forests at Scarboro, Me. Pine stubs in high marsh. September, 1931

yards wide and 25 feet deep. The scouring of this great channel was accomplished largely during the first 30 years, having become slow in the last two decades. The final five feet of downcutting has been through the stony clay.

In this forest we mapped a total of 38 fallen trees and 77 stumps, but we were unable to obtain more than 20 useful sections, all from prostrate trunks. All sections were of coniferous wood, chiefly white pine and hemlock with one each of spruce and Norway pine. The average age was 140 years, with very few under 100 years.

Scarboro, Odiorne Point, and Provincetown Sites

The Scarboro forest lies half buried in the salt marsh near Scarboro railway station about six miles west of Portland. Hundreds of stumps and an occasional fallen tree are exposed at the thin upper edge of the salt marsh and farther out where a meandering creek undercuts the turf and the more deeply buried part of the forest bed. A few stumps on the upper border of the marsh stand close to a living forest (*Pinus rigida* and *P. strobus*). These dead stumps protrude from the ground much as stumps do after a logging operation, except that in most cases a mound of fibrous soil surrounds the wood. Perhaps they have been forced up a little by frost action in the wet marsh. But generally the forest is nearly or entirely buried. Where the creek undercuts the marsh several large stumps with irregular tops and spreading roots have been exposed, and a few have dropped into the channel. These indicate that the old forest floor sloped gently toward the ocean, so that in a distance of 200 yards from the living trees the original ground level is three or four feet under the top of the marsh.

The wood here is not well preserved, probably because, lying as it does high above mean tide level, it has more chance to rot. All sections collected proved to be pines like those of the living forest close by—chiefly pitch pine with a few white pine.

A resident of Portland who lived near this locality in 1868 vouches for the statement that the whole appearance of the marsh and of the stumps in its surface is the same today as it was 65 years ago. When the railroad was put through at that time, workmen excavating for the roadbed turned up hundreds of these stumps at a depth of about four feet. Belief in stability here during the last 60 or 70 years is further supported by the lack of recently killed trees along the line where the modern forest meets the marsh. Young trees from 10 to 50 years old are growing along this line, but they are not mingled with the stumps of trees killed long ago.

The Odiorne Point forest lies in a circular cove about 500 feet in diameter with a narrow opening at low tide between ledges on its

seaward side that partly protect it from wave action. At this point the highway from Portsmouth to Hampton Beach runs so close to the water that the highest stumps are only 200 feet east of the road. The forest is only partly preserved, being represented at present by a rather compact group of stumps, fallen trees, and more numerous remnants of root systems of stumps long since removed by waves and shore ice. The wood, however, is in good condition. Shallow pools of water surround the higher stumps when the tide is out, and the lower part of the cove never drains entirely.

Fourteen tree sections were collected from this place. Later identification showed the species to be white pine, hemlock, and maple, but eleven were pine about 100 years old. The highest stump of those sampled stands nearly three feet above the lowest one, and about 350 feet away. It seems likely that this forest was first buried by salt marsh and exposed in comparatively recent time by retreat of the beach and the scouring away of its foreslope.

On the northern margin of the inner harbor at Provincetown, near the state highway, there is a small, compact group of stumps at about mean sea level. Twenty-five or thirty stumps and fallen trees appear, but sand undoubtedly covers many others. Most of the trees are pitch pine, but about half of the sections cut were of the better preserved hardwoods—maple, birch, and oak. These average only 50 to 75 years in age, and because the 11 sections are divided among 4 species of trees that grew almost at the same level, this forest is of little or no help in the solution of our problem.

Collection and Measurement of Sections

Each of the five forest sites furnished from 10 to 25 well preserved stumps or fallen trees from which complete sections of the trunk could be made. Although in the case of badly worn stumps it was necessary to cut the sections low, where flares give false widths to the later rings, difficulty in matching could be overcome by using measurements of rings inside the expanded region. The best sections were obtained from fallen trees with roots still in place.

As each section of a stump or fallen tree was cut in the field, it was labeled securely with the number given the tree on the map, where its exact position and ground altitude were indicated. Several hundred trees were thus accurately mapped, but only about 80 were in condition to furnish sections of both wood and bark. Though the bark usually fell off, the wood thus exposed is easily distinguished by its smooth surface.

The numbered sections were taken to the laboratory, where they were allowed to dry at room temperature. As soon as their condition permitted, accurate measurements of ring widths were made with a

ten-power dissecting binocular and ocular scale along as many average radii as possible up to four. To bring out the precise limits of the individual rings of wood, the sections were either planed or band-sawed into two sections each. According to the condition of the wood, the newly exposed surface was then either polished or notched with a razor blade along the desired radii. As measurements were

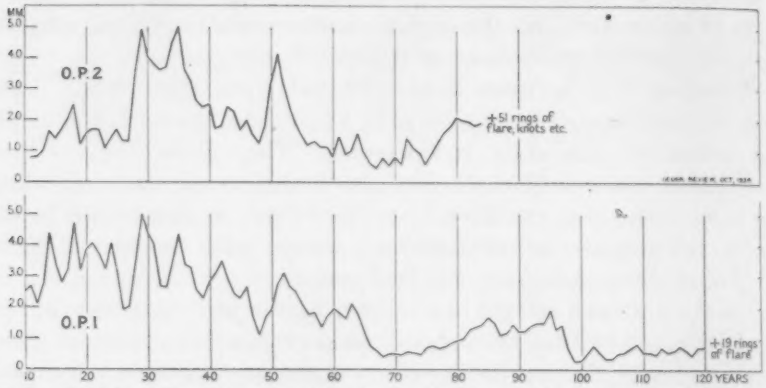

FIG. 5—Partial growth records of two white-pine trees from drowned forest at Odiorne Point, showing good cross-identification. Later rings lost to complete analysis. Ages of trees (identical) on horizontal axis; mean widths of rings on vertical axis.

made from center to bark, the count in each radius was checked by following every thirtieth or fortieth ring around the section from one radius to another. If its number was found to be the same along all radii, there was no question of false rings, wedged-out rings, and similar anatomical variations in wood. Through this precaution a number of errors were avoided or corrected.

From the tabulated list of ring widths the mean thickness of wood growth was computed for each year. The means were then plotted into a graph for each tree, with the years from left to right along the horizontal axis and the ring widths along a vertical axis. Each curve thus drawn showed marked fluctuations from year to year, with prominent highs, lows, and other features of good "character." The location of the bark, if present, was noted at the end of each curve, as a certain record of the death of the tree.

Determination of the species of tree was by no means easy, for woods saturated long with sea water are surprisingly alike in appearance. Exact microscopical determination of each specimen was kindly furnished by the U. S. Forest Products Laboratory at Madison, Wis., through Mr. Arthur Koehler. At least nine species of trees were found in the collections, with as many as six from a single forest site. This interfered seriously with the use of our data, because it appears hopeless to attempt to cross-identify curves of such widely divergent species as oak, beech, maple, white pine, pitch pine, birch, hemlock,

spruce, and fir balsam. We have given consideration to possible matches between white pine and hemlock and between white and pitch pine, because they grow side by side and probably differ no more in their response to climatic and environmental changes than do two individuals of the same species. In most cases oak, birch, and maple were represented by only one or two sections, and these

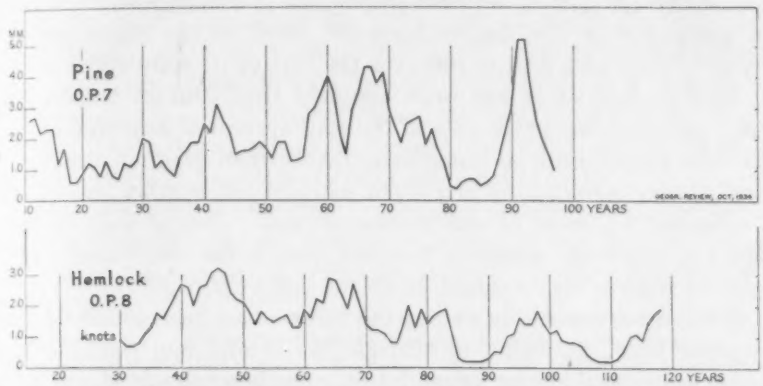

FIG. 6—Cross-identification between pine and hemlock trees from drowned forest at Odiorne Point. Ages of trees on horizontal axis; mean widths of rings on vertical axis. Pine (upper graph) killed 17 years before hemlock.

were omitted entirely. Almost all our efforts toward cross-identification were made with pine and hemlock, which were most numerous and favorably grouped.

RESULTS FROM COMPARISON OF TREE-RING GRAPHS

Previous work with sections of modern trees in New England, particularly old hemlocks, has indicated that cross-dating of contemporary individuals is not especially difficult.[13] Not every tree reflects the irregular occurrence of good and poor growing seasons, but in a group the majority can be expected to show at least the effects of marked droughts. Consequently it was a disappointment to find that our laboriously plotted graphs could not be matched consecutively through a group of trees. Surely the fault does not lie in any lack of character or individuality in the graphs, for the representative cases shown in Figures 5 and 6 display rings that are far from "complacent." The trouble seems rather to be that submergence proceeded at such a slow rate that the trees as a group were not contemporaries.

In certain cases pairs of graphs seem to match. For example, the two trees from which the partial growth records were taken for

[13] A. E. Douglass: Climatic Cycles and Tree-Growth, *Carnegie Instn. Publ. No. 289* [Vol. 1], 1919, pp. 41–42; C. J. Lyon: Rainfall and Hemlock Growth in New Hampshire, *Journ. of Forestry* (in press).

Figure 5 grew close together and at nearly the same altitude. Correspondence between their graphs was therefore to be expected. These trees were both white pine. In Figure 6 are shown the complete growth records of two other trees in the same forest. Again cross-dating is fairly satisfactory, although one tree was white pine and the other hemlock. However, we have found so few such cases of acceptable matching between graphs that it was impossible to follow the succession of tree deaths from the lower to the higher levels of any one forest and thus to discover the rate of its submergence.

In this analysis it has been assumed that contact between salt water and the absorptive area of the root system of any pine or hemlock tree would result in immediate, rather than gradual, death. Indeed, abrupt termination of growth without preliminary loss of vigor is indicated by most of our measurements. This is well shown in Figure 6, where the tendency to wider rings in the buttressed bases of vigorous trees is very evident up to the last year of life.

If all the trees in any one of the forests had been killed at about the same time, regardless of altitude, we should find that plenty of the sections would show cross-dating. Such wholesale death might be attributed to the breaking of a barrier between ocean and forest or to a quick displacement of the earth's crust by earthquake movement. The absence of cross-identification to this extent makes it highly improbably that submergence and death of the forests were due to those causes.

We can only conclude that submergence was so slow at these forest sites that a long time elapsed between the killing of one tree and the next. If successively drowned individuals lived at the same time, their growth periods overlap for too short a time to be cross-dated. Either eustatic rise of the sea or downward crustal movement is a possible cause, but we cannot choose between them.

MAGELLAN'S ROUTE IN THE PACIFIC

George E. Nunn

WHAT was the course followed by Magellan between the strait that now bears his name and the Philippine Islands? As usually described and plotted on modern maps this course ran northward along the west coast of South America for a relatively short distance; at about latitude 32° S. it turned out into the open ocean and made directly for the Philippines in a west-northwesterly direction. The writer believes that such a route is improbable and that the navigator, before turning westward, proceeded much farther north than has hitherto been supposed (Fig. 1).

The information available concerning Magellan's route in the Pacific is derived from the sources indicated in the footnote below.[1] The plot of the voyage as ordinarily given by modern authorities[2] is

[1] Francisco Albo: Diario ó derrotero [log book] del viage de Magallanes desde el cabo de San Agustin en el Brasil . . . , in M. F. de Navarrete: Coleccion de los viages y descubrimientos . . . , 5 vols., Madrid, 1825–1837, Vol. 4, pp. 209–247, especially pp. 216–220. English translation of extracts from this log book in Lord Stanley of Alderley, transl. and edit.: The First Voyage Round the World, by Magellan, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 52, London, 1874, pp. 211–236.

[Genoese Pilot]: Navigation and Voyage Which Fernando de Magalhães Made from Seville to Maluco in the Year 1519. English translation in Alderley, *op. cit.*, pp. 1–29, especially p. 9.

Antonio Pigafetta: Magellan's Voyage Around the World, transl. and edit. by J. A. Robertson, 3 vols., Cleveland, 1906, especially Vol. 1, pp. 83–99.

Maximilian of Transylvania: A Letter from Maximilianus Transylvanus to the Most Reverend Cardinal of Salzburg . . . English translation in Alderley, *op. cit.*, pp. 179–210; also in Henry Stevens, transl.: Johann Schöner . . . , A Reproduction of His Globe of 1523 . . . , edit. by C. H. Coote, London, 1888, pp. 101–146, especially pp. 125–126.

Antonio Brito: Carta de Antonio Brito al Rey de Portugal sobre algunos sucesos en la India y los del viage de Magallanes, in Navarrete, *op. cit.*, Vol. 4, pp. 305–311, especially p. 308.

Peter Martyr D'Anghera: De Orbe Novo, transl. and edit. by F. A. MacNutt, 2 vols., New York and London, 1912, Dec. V, Book 7 (Vol. 2, pp. 156–157).

G. F. de Oviedo y Valdés: Historia general y natural de las Indias . . . , edit. by J. A. de los Rios, 4 vols., Madrid, 1851–1855, Book 20, Chs. 1 and 2 (Part 2, Vol. 1, pp. 13 and 22).

[Anonymous Portuguese]: Narrative of a Portuguese, Companion of Odoardo Barbosa, in the Ship *Victoria*, in the Year 1519. English translation in Alderley, *op. cit.*, pp. 30–32.

Alonso de Santa Cruz: Islario general de todas las islas del mundo . . . , *Bol. Real Soc. Geogr.*, Madrid, Vol. 60, 1918, pp. 7–88, 231–264, 383–392, and 491–516; Vol. 61, 1919, pp. 69–128, 217–288, 437–480, and 504–728; especially Vol. 61, p. 727.

João de Barros: Da Asia . . . , 24 vols., Lisbon, 1777–1788, Dec. III, Book 5, Chs. 9–10 (Vol. 5, pp. 632–663, especially pp. 647–648).

Gaspar Correa: Lendas da India, 4 vols., Lisbon, 1858–1866, Vol. 2, Part 2, Ch. 14, p. 630.

Fernão Lopes de Castanheda: Historia do descobrimento e conquista da India pelos Portugueses, Coimbra, 1554, Book 6, Ch. 8.

Francisco López de Gómara: Historia general de las Indias, 2 vols., Madrid, 1922, Chs. 91–93 (Vol. 1, pp. 213–226).

Antonio de Herrera: Historia general . . . , 4 vols. (in which each decade is paged separately), Madrid, 1726–1730, Dec. II, Book 9, Ch. 15 (pp. 236–238); Dec. III, Book 1, Chs. 3–4 (pp. 4–7).

B. L. de Argensola: Conquista de las islas Malucas . . . , Madrid, 1609, pp. 15–18.

The writer's attention has been called to an account of Magellan's voyage, derived from two of his sailors found by the Portuguese on the island of Timor. This account has been published by Sr. António Daião in the *Arquivo Histórico de Portugal*, Vol. 1, Parts 5 and 6, 1933. It has not been available to the writer as yet.

[2] James Burney: A Chronological History of the Discoveries in the South Sea or Pacific Ocean, 5 vols., London, 1803–1817, Vol. 1, frontispiece.

Justin Winsor, edit.: Narrative and Critical History of America, 8 vols., Boston and New York, 1884–1889, Vol. 2, p 610.

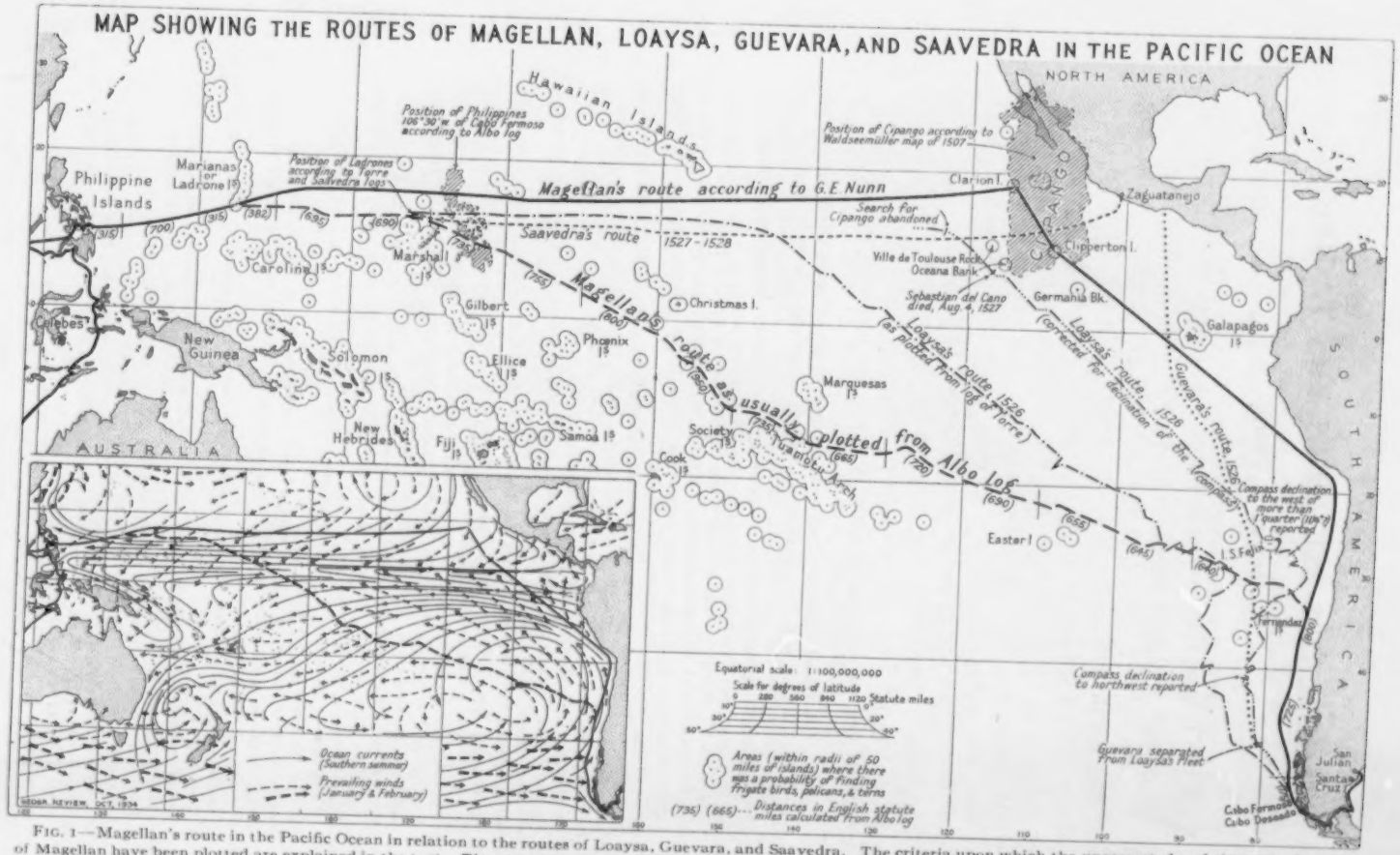
MAP SHOWING THE ROUTES OF MAGELLAN, LOAYSA, GUEVARA, AND SAAVEDRA IN THE PACIFIC OCEAN
NORTH AMERICA
SOUTH AMERICA
AUSTRALIA
Hawaiian Islands
Position of Philippines 106° 30′ W. of Cabo Fermoso according to Albo log
Position of Cipango according to Waldseemüller map of 1507
Position of Ladrones according to Torre and Saavedra logs
Philippine Islands
Marianas or Ladrone Is.
Magellan's route according to G. E. Nunn
Saavedra's route 1527–1528
Search for Cipango abandoned
Clarion I.
Zaguatanejo
Clipperton I.
Ville de Toulouse Rock
Oceana Bank
Sebastian del Cano died, Aug. 4, 1527
Germania Bk.
Galapagos Is.
Caroline Is.
Marshall Is.
Gilbert Is.
Christmas I.
Celebes
New Guinea
Solomon Is.
Ellice Is.
Phoenix Is.
Magellan's route as usually plotted from Albo log
Loaysa's route 1526 (as plotted from log of Torre)
Loaysa's route 1526 (corrected for declination of the compass)
Grijalva's route 1526
Marquesas Is.
New Hebrides
Fiji Is.
Samoa Is.
Society Is.
Tuamotu Arch.
Cook Is.
Easter I.
I. S. Felix
Compass declination to the west of more than 1 quarter (11°) reported
Fernandez Is.
Compass declination to northwest reported
Guevara separated from Loaysa's fleet
San Julian
Santa Cruz
Cabo Fermoso
Cabo Deseado
Equatorial scale: 1:100,000,000
Scale for degrees of latitude
0 280 560 840 1120 Statute miles
Areas (within radii of 50 miles of islands) where there was a probability of finding frigate birds, pelicans, & terns
(735) (665)... Distances in English statute miles calculated from Albo log
Ocean currents (Southern summer)
Prevailing winds (January & February)
MEDIA REVIEW, OCT. 1934

FIG. 1—Magellan's route in the Pacific Ocean in relation to the routes of Loaysa, Guevara, and Saavedra. The criteria upon which the uncorrected and the revised routes of Magellan have been plotted are explained in the text. The uncorrected route of Loaysa is plotted from the log of Hernando de la Torre; the route corrected for magnetic declination is also shown. For Guevara's route see Oviedo: Historia general, Book 20, Ch. 12 (Part 2, Vol. 1, pp. 50–55). Saavedra's route is plotted from the log by Francisco Granado, Navarrete, *op. cit.*, Vol. 5, pp. 465–475. On the inset map of ocean currents and winds during the southern summer the uncorrected and the revised routes of Magellan are shown.

based almost entirely on the log of Francisco Albo. The other accounts either are very brief as far as the route is concerned or else, like the letter of Antonio Brito, are mere summaries of Albo's log.

Privations Suffered by the Expedition

The conditions under which the expedition left the strait and the privations that it suffered subsequently will be considered first. As is explained a little later, they cast grave doubts upon the reliability of the Albo log.

There had been a mutiny in the Bay of San Julian, on the east coast of Patagonia, caused partly by quarrels among the leaders, partly by the domineering attitude of Magellan, and partly by reduced rations. After entering the strait, Magellan asked the opinion of the captains and pilots concerning the advisability of going on or of returning to Spain. Herrera states that Estevan Gomez opposed the continuation of the voyage because supplies were low, the "great gulf" had to be crossed, and a calm would be fatal.[3] Barros asserts that Andres de San Martin answered Magellan to the effect that, while there were sufficient supplies for the present, there were not supplies enough or of a proper kind to sustain or renew the strength of men subjected to unusual work.[4] However, San Martin added that it would be proper for Magellan to do as he thought best about going on or returning to Spain. Magellan, of course, had no intention of turning back. Whichever of these reports is the truth, it is clear that the question of the sufficiency of the supplies was prominent in the minds of everybody concerned.

On November 28, 1520, the fleet of three vessels entered the Pacific Ocean. Before the first inhabited land was reached the greatest sufferings were experienced. Pigafetta writes:

> We were three months and twenty days without getting any kind of fresh food. We ate biscuit, which was no longer biscuit, but powder of biscuits swarming with worms, for they had eaten the good. It stank strongly of the urine of rats. We drank yellow water that had been putrid for many days. We also ate some ox hides that covered the top of the mainyard to prevent the yard from chafing the shrouds, and which had become exceedingly hard because of the sun, rain, and wind. We left them in the sea for four or five days, and then placed them for a few moments on top of the embers, and so ate them; and often we ate sawdust from boards. Rats were sold for one-half ducado apiece, and even then we could not get them. But above

Footnote 2 (continued). J. T. Medina: El descubrimiento del Océano Pacífico . . . , 4 vols., Santiago de Chile, 1913–1920, Vol. 3, pp. cci and cclxxxiii.

Jean Denucé: Magellan: La question des Moluques et la première circumnavigation du globe, *Mémoires Acad. Royale de Belgique, Classe des Lettres et des Sci. Morales et Polit et Classe des Beaux-Arts*, Ser. 2, Vol. 4, Brussels, 1908, opp. p. 294.

F. H. H. Guillemard: The Life of Ferdinand Magellan . . . , London, 1890, opp. p. 142.

Oscar Koelliker: Die erste Umseglung der Erde durch Fernando de Magallanes und Juan Sebastian del Cano, 1519–1522, Munich and Leipzig, 1908, opp. p. 49.

[3] Herrera, *op. cit.*, Dec. II, Book 9, Ch. 15 (pp. 236–237).

[4] Barros, *op. cit.*, Dec. III, Book 5, Ch. 9 (Vol. 5, pp. 640–646). According to Herrera and Navarrete this consultation occurred before the desertion of the *San Antonio*. According to Barros it occurred after that event and just before Magellan's entry into the Pacific.

all the other misfortunes the following was the worst. The gums of both the lower and upper teeth of some of our men swelled, so that they could not eat under any circumstances and therefore died. Nineteen men died from that sickness, and the giant together with an Indian from the country of Verzin. Twenty-five or thirty men fell sick [during that time], in the arms, legs, or in another place, so that but few remained well.[5]

Luckily the expedition suffered no other misfortunes. Pigafetta adds:

We sailed about four thousand leguas during those three months and twenty days through an open stretch in that Pacific Sea. In truth it is very pacific, for during that time we did not suffer any storm. . . . Daily we made runs of fifty, sixty, or seventy leguas at the catena or at the stern. Had not God and His blessed mother given us so good weather we would all have died of hunger in that exceeding vast sea. Of a verity I believe no such voyage will ever be made [again].[6]

Herrera's comments are to the same effect. He writes that

between the tropics a current flows from the east so strongly and consistently that for many days it was not necessary for the sailors to touch the helm or the sails, because they were sailing in that vast ocean as if it were a canal or a peaceful river. Therefore Magellan called that ocean the Pacific Ocean.[7]

Almost No Signs of Land Seen

Certainly the expedition when it was in such straits as are described by Pigafetta would have made every effort to find relief in any land along the route, especially after the middle of January. If the route as usually plotted from the Albo log is correct, Magellan passed between the Marquesas and Tuamotu archipelagoes shortly after the middle of January. A little later he passed near Malden Island and not far from Christmas Island. When the privations were at their worst the expedition was skirting the Marshall Islands to the east and the north for a distance of 500 miles. But during the entire voyage after leaving the vicinity of the South American coast at about latitude 32° S. and before reaching the Ladrones the only lands actually sighted were two barren, uninhabited rocks or islands, "San Pablo" and "Tiburones." Apparently no signs whatever of any other lands were noticed.

It is possible to mark out on a map a route between South America and the Ladrones that avoids contact with all but two barren rocks, as does the route plotted from the Albo log. To follow such a route, however, it would almost be necessary to know beforehand where to sail, and it is extremely unlikely that a fleet in the condition of Magellan's could have passed through the island groups of the South Pacific without observing indications of other lands than the two rocks reported.

[5] Pigafetta, *op. cit.*, Vol. 1, pp. 83 and 85.
[6] *Ibid.*, p. 85.
[7] Herrera, *op. cit.*, Dec. I, Book 9, Ch. 12 (p. 252).

Before land is sighted a practical seaman is aware of its presence through many signs. Such signs begin to appear at a considerable distance from shore. The most noticeable is the presence of shore birds such as the frigate bird, pelican, tern, gannet, cormorant, and gull, which seek the land at night. The Portuguese are known to have discovered several islands by watching the directions of bird flights at nightfall. Flores in the Azores was so discovered.[8] Columbus noted that the frigate bird (*rabiforcado*) was seen at an extreme distance of about 100 miles, while the pelican (*alcatraz*) appeared at some eighty miles from shore.[9]

The species of birds whose presence would indicate the vicinity of land differ in different parts of the world. Those present in the part of the Pacific crossed by Magellan are the frigate bird, booby, tropic bird—both white and red-tailed—and many varieties of tern.[10] Among these shore birds the strongest flier is the frigate bird, called the "eagle of the sea." The frigate bird has sometimes been seen as far as "six hundred to seven hundred miles from the nearest coast, but generally speaking it seldom flies to more than from twenty to fifty miles from shore to which it usually resorts in stormy weather."[11]

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[8] *Ibid.*, Dec. I, Book 1, Ch. 3 (p. 5).

[9] C. R. Markham, transl.: The Journal of Christopher Columbus . . . , *Hakluyt Soc. Publs.*, Ser. 1, Vol. 86, London, 1893, p. 30 (see also pp. 23, 25, 26, 27, 31, 32, and 33). Markham translates *alcatras* (pelican) as booby (see pp. 26, 27, 31, and note 2 on p. 26).

[10] W. B. Alexander: Birds of the Ocean, New York and London, 1928, pp. 372–374.

[11] T. R. Jones: Cassell's Book of Birds: From the Text of Dr. Brehm, 4 vols., London, [1869–1873]; reference in Vol. 4, p. 225.

In a letter to the present writer Dr. Robert Cushman Murphy of the American Museum of Natural History in New York states that the entire area covered by the South Pacific islands north of the Tropic of Capricorn is frigate-bird territory. "Most of the islands are also the home of one or more species of tern. Both frigate birds and terns normally spend the night at shore-roosts, and Watson has shown that the sooty tern will become bedraggled, and will even drown, after an enforced rest on the water. Sooty terns nest in vast colonies at Christmas Island, the Marquesas, many of the Tuamotus, and elsewhere within this region. Their afternoon flights, in one direction, nearly always indicate the presence of an island, a fact useful to navigators of both ancient and modern times. Bridled terns, crested terns, fairy terns, and noddies of two species fill much the same rôle in the part of the Pacific with which you are concerned, but the frigate birds and sooty terns are probably the most reliable indices.

"The homing propensities of the frigate birds are used by Marshall Island missionaries for sending messages from island to island. The midge-like clouds of sooty terns are often visible over low coral islands before the land is raised. I agree with you that Magellan could hardly have passed through the Tuamotu-Marquesas region without being drawn to the islands by birds, if, indeed, his vessel could have avoided running aground, birds or no birds.

"Ordinarily sooty terns do their feeding within 40 or 50 miles of land. A vast majority of them are much closer to the breeding ground during their daily excursions for food. . . .

"However, during the migration periods the sooty terns sometimes go very much farther from land. They come annually to Ascension Island from nobody knows where. Once I saw numbers of them along the coast of central Peru, many hundreds of miles from any possible breeding ground.

"The presence of many islands of an archipelago might increase the ordinary feeding flight range of frigate birds, but I can find no specific information upon the subject. Ordinarily they do not go very far from their breeding or roosting station, and I should say that a 50-mile radius would be a liberal allowance except for the occasional straggling bird. Frigate birds have been found as far as 300 miles or more from the nearest land, but the fact is highly exceptional.

"The range of the other species of terns, including the noddies, would be similar to that of the sooties. All such birds fly forth from their breeding grounds for only a few miles. At evening one often sees them streaming back in fairly direct lines, a fact which navigators in the Pacific have often taken advantage of when searching for a particular landfall. Christmas Island of the Line Group, for instance, has been picked up many a time by running down the line of homing terns."

Bearing this in mind, we see that, as regards discovery, the merest bird rock becomes much more than a tiny spot in the vast ocean. If the shore birds fly only 50 miles from land, their range of flight potentially covers an area of $\pi (50)^2$, or 7854 square miles—an area nearly as large as the state of Massachusetts. The accompanying map (Fig. 1) shows that the Pacific is filled with evidence of land if each of the many islands is enclosed by a circle of 50-mile radius. This map makes clear what a marvelous occurrence it would have been for Magellan to sail the route as credited in the Albo log and to miss all but two rocks in the entire Pacific.

Discrepancies Regarding the Route

When the various accounts of the voyage are compared one with another, wide discrepancy is found in regard to the point where Magellan started to cross the Pacific, the latitude of San Pablo and Tiburones islands, and the direction and distance the expedition sailed—the three most significant matters to be considered in determining the route. Before we consider these problems, however, a word must be said in regard to the longitudes and latitudes given in the contemporary records.

A few longitudes are recorded, but the record has little or no value. Longitudes mentioned by the early discoverers fall into two groups. The best are those computed from eclipses and star conjunctions when the observer was on land. The others are the result of calculations based on dead reckoning, checked with directions, estimated distances, and latitudes where available.

In addition to his account of Magellan's voyage, Pigafetta wrote a "Treatise of Navigation," in which he says:

> At the present time the pilots content themselves with knowing the latitude; and are so proud that they will not hear speak of longitude.[12]

Maximilian of Transylvania had little confidence in Magellan's longitudes. He observes:

> Yet our sailors seem to me rather to be mistaken in the calculation of the longitudes (of distances?) than to have fixed them with any certainty, because in so long a voyage, and being so distant from the land, they cannot fix and determine any marks or signs for the longitude. Still I think that these accounts, whatever they be, should not be cast aside, but rather accepted till more certain information be discovered.[13]

The unreliability of both the longitudes and the latitudes is evident when we compare the data derived from the men who took part in the expedition. For convenience these data are tabulated in Tables I,

[12] Antonio Pigafetta: Treatise of Navigation. English translation in Alderley, *op. cit.*, pp. 164-174; reference on p. 167.

[13] Maximilian of Transylvania, *op. cit.*, Alderley's edition, p. 189; Stevens' edition, p. 115. There is considerable difference in the sense between the two translations.

TABLE I—ESTIMATED AND ACTUAL LONGITUDES PERTAINING TO MAGELLAN'S VOYAGE

	DIFFERENCE IN LONGITUDE	
	Estimated	Actual
1. Rio de Janeiro, west of Seville, Spain	268° 45′[a]	37° 30′
2. San Julian Bay, west of Canaries	56°[b]	50° 30′
3. Philippines, west of Cape Fermoso	106° 30′[c]	159°
4. Spice Islands, east of Line of Demarcation in Atlantic Ocean		174°
a. According to Magellan	184°[d]	
b. Spanish estimate at Congress of Badajoz, 1524	210°[e]	
c. Portuguese claim	159°, 163°[f]	

[a] Based on an observation of the conjunction of Jupiter with the moon made October 17, 1519, which showed a difference of 17 hours, 55 minutes (Barros, Da Asia, Dec. III, Book 5, Ch. 10, Lisbon edition, 1777–1778, pp. 657–662); M. de la Puente y Olea, Los Trabajos Geográficos, pp. 335–336.

[b] Stevens, Johann Schöner, p. 114.

[c] Alderley, The First Voyage Around the World, p. 224.

[d] Navarrete, Coleccion, etc., Vol. 4, p. 189.

[e] *Ibid.*, p. 354.

[f] *Ibid.*, p. 367. According to the Portuguese, from Sal to the Moluccas was 133° or 137°; from Sal to the Line of Demarcation, 26°; from Sal to San Antonio, 4° (*ibid.*, p. 366); from San Antonio to Line of Demarcation, 22° (*ibid.*, p. 188).

II, III, and IV. The wide variations among the several calculations and their variance from the truth, where discoverable, are sufficient to show their questionable value.

WHERE DID MAGELLAN TURN WESTWARD?

From Table II it will be seen that there is a difference of nearly the whole length of South America in regard to the point where

TABLE II—INDICATIONS OF LATITUDES IN REPORTS OF MAGELLAN'S VOYAGE[a]

(A) MISCELLANEOUS DATA

Oviedo:	(1) A course following the sun to the northwest because he knew that the Moluccas were in the extreme east near the equator. He sailed three months and twenty days. (2) Magellan's intention was to seek a passage to the other sea, to pass around Tierra Firme to the equator, and then to sail near it to find the Moluccas.
Herrera:	North to latitude 32° 20′ S. Thence northwest and west-northwest 2800 leguas. In latitude 15° 48′ N. Magellan discovered the Ladrones. This discovery was made on January 20, 1520 (?) according to Herrera. This is an error: the Ladrones were discovered March 6.
Cómara:	North to the equator and thence west to the Moluccas. Moluccas not very distant from Panama and the Gulf of Sant Miguel.
Correa:	Sailed with the east wind at the stern for five months without lowering the sails.
Barros:	North to temperate climate. Thence west-northwest for four months. On west-northwest course Magellan passed 180° of longitude west of the Canary prime meridian. Magellan went north of the equator to 15° 30′ to find either mainland or islands in order to locate himself. He discovered some desert islands in this latitude. Then he went north to latitude 21° N. There he turned south again and found inhabited islands (Guam).
Anonymous Portuguese:	Between west and northwest 9858 miles to equator. Thence west and northwest 2046 miles to several islands between latitudes 10° and 12° N.
Peter Martyr:	Northwest three months and twenty days to the Ladrones.
Brito:	North to latitude 32° S. Thence west-northwest 1600 leguas to latitude 12° N. Thence west 500 leagues to the Ladrones.
Maximilian of Transylvania:	Between north and west for three months and twenty days, driven by a strong wind. Magellan found an island called Inuagana (Guam) 11° N. and 158° W. of Cadiz.
Genoese Pilot:	West-northwest, passing the equator, to latitude 13° N. Thence west 100 leagues to the Ladrones.

[a] See p. 615, footnote 1, for more complete references to original sources.

TABLE II (continued)

Pigafetta: Sailed 4000 leagues west-northwest, northwest-by-west and northwest to the equator at 122° west of Line of Demarcation. Thence west-northwest and west-by-north and then 200 leagues west. Then west-by-south to latitude 13° N. After seventy leagues on this course in latitude 12° N. discovered the Ladrones. Pigafetta writes that the Ladrones were 146 degrees in longitude, but does not say from where. Apparently he meant from the Line of Demarcation because he placed the crossing of the equator 122° and 30° from the "meridian."

Santa Cruz: Northwest quarter to the west 1500 leagues to Sanct Pablo in latitude 17° S. Northwest 180 leagues to Tiburones in latitude 11° S. Santa Cruz placed Sanct Pablo south of the island (California) discovered by Cortes.

Argensola: After passing the strait he placed himself under the equinoctial but could not find the Moluccas. He reached Zebu in the Philippines. This failure was due to the ocean currents or to defective maps.

Castanheda: From the strait went to seek the equator, because he knew from the letters of Francisco Serrano that the Moluccas were on the equator. Sailed five months without finding the Moluccas.

(B) DATA FROM LOG OF FRANCISCO ALBO (1520–1521)*

Direction Sailed and Latitude

1520			
Nov. 28–30		52° S.	Cape of the Virgins and Cape Fermoso NW, N, and N–NE over 55 leagues
Dec. 1		48° S.	
2	N–NE	47¾° S.	
3	NW	46° 30′	
4	NW	45½°	
5	N–¼NW	44¼°	
6	NE–¼E	44°	
7	NE–¼E	43⅔°	
8	NE–¼N	43¼°	
9	N–NE	42⅔°	
10	NE–¼E	42° 12′	
11	NE–¼E	41⅔°	
12	NE–¼E	41¼°	
13	NE–¼N	40°	
14	N	38¾°	
15	N–¼NE	38°	
16	N–¼NW	36½°	
17	NW–¼N	34½°	
18	N–¼NW	33½°	
19	NW	32¾°	
20	NW	31¾°	
21	NW	30⅔°	
22	W–¼SW	30⅔°	
23	W–NW	30°	
24	W–NW	29¾°	
25	W–NW	29½°	
26	NW–¼W	28¾°	
27	NW–¼W	27⅔°	
28	NW–¼W	26⅔°	
29	W–NW	26½°	
30	W	12 leagues	
31	NW	25½°	
1521			
Jan. 1	W–¼NW	25°	
2	W–NW	24°	
3	NW–¼W	23½°	
4	W–NW	22°	
5	W–¼SW	23°	
6	W–¼NW	22°	
7	W	25 leagues	
8	W	23 leagues	
9	W–¼NW	22¼°	
Jan. 10	W–¼NW	22°	
11	W–¼NW	21¾°	
12	W–¼NW	21½°	
13	W–¼NW	21°	
14	NW–¼W	20½°	
15	W–NW	19½°	
16	W–NW	19°	
17	W–NW	18¼°	
18	W–NW	17½°	
19	NW–¼W	16¼°	
20	NW–¼W	15°	
21	SW	15⅔°	
22	SW	16¾°	
23	W–¼NW	16½°	
24	W–¼NW	16¼°	Here discovered an uninhabited island, San Pablo
25	NW–¼W	15¾°	
26	NW–¼W	15½°	
27	NW–¼W	15°	
28	W–NW	14½°	
29	W–NW	13¾°	
30	W–¼NW	13½°	
31	W–¼NW	13½°	
Feb. 1	NW	13°	
2	NW	12½°	
3	NW	11¾°	
4	NW	11¼°	Here found uninhabited island, caught many sharks, gave it name of Tiburones
		10⅔°	
5	NW	10°	
6	NW	9¼°	
7	NW	8⅔°	
8	NW	7⅔°	
9	NW–¼W	6½°	
10	NW	5°	
11	NW	2½°	
12	NW	1°	
13	NW	0° 30′ N.	
14	NW	1° N.	
15	NW	1¾°	
16	W–NW	2½°	
Feb. 17	W–NW	3½°	
18	W–NW	5°	
19	W–NW	5¾°	
20	W–NW	6½°	
21	W–NW	8°	
22	W–NW	9½°	
23	W–NW	11½°	
24	W–¼NW	12°	
25	W–¼NW	12½°	
26	W	12°	
27	W	12°	
28	W–¼NW	13°	
Mar. 1	W	13°	
2	W	13°	
3	W	13°	
4	W	13°	
5	W	13°	
6			Discovered Ladrones. Ladrones are 300 leagues from Gilolo.
9	W–¼SW	12⅔°	
10	W–¼SW	12½°	
11	W–¼SW	12°	
12	W–¼SW	11½°	
13	W–¼SW	11°	
14	W–¼SW	10⅔°	
15	W–¼SW	10°	
16			Saw land, called Suluano in the Philippines.

From Strait of All Saints and Cape Fermoso to Philippines is 106° 30′ of longitude in a straight course W–NW and E–SE. Suluan is 180° of longitude from the meridian (Canary). On Jan. 24, when at San Pablo log states it is 9 grados to Tiburones: on Mar. 6, that the Ladrones are 300 leguas from Gilolo. This is evidence that the log was written after arrival in the Spice Islands.

* Navarrete, *op. cit.*, Vol. 4, pp. 216–220. There are several errors in the Alderley version of the log.

Magellan turned west to cross the Pacific. Pigafetta, Maximilian of Transylvania, the Genoese pilot, the anonymous Portuguese, Oviedo, Peter Martyr, Correa, and Santa Cruz seem to indicate an immediate departure from the South American continent into the vastness of the ocean. Albo, Brito, and Herrera tell of Magellan's going north to latitude 32° S. before starting westward. Barros is indefinite. Oviedo states that the plan was to go north to the equator and thence along the equator to the west, and according to Gômara, Castanheda, and Argensola this is the course that was actually taken. Castanheda's words are as follows:

> And from there [the Strait of Magellan] Fernando Magellan ordered that they should go to the equator because he knew from the letters of Francisco Serrano and from the old sea charts that the Moluccas lay on the equator; and sailing north until he had placed himself on the equator he sailed five months without finding the Moluccas, concerning this he as well as his pilots and his astrologer were much troubled.[14]

According to the Albo log Magellan followed the South American coast north to latitude 32° S., which was reached on December 19, 1520. The entire voyage from the strait to the Philippines occupied the period between November 28, 1520, and March 16, 1521, or 109 days in all. Two days were spent at Tiburones and four days at the Ladrones, leaving 103 days for sailing a distance of about 13,000 English statute miles. If, as Albo states, the expedition left the vicinity of the coast of South America at latitude 32° S. on December 19, it must have consumed 22 days in sailing to that point from the strait (52° S.) and then covered the remaining 11,400 miles in 81 days, or at a rate nearly twice as fast. The average wind and current conditions off the South American coast from the strait north do not indicate that unusual difficulties might have been encountered in that part of the route except between the strait and latitude 47° S.—in fact the current is favorable. But, according to the Albo log, this parallel—47° S.—was reached in two days only. None of the narratives of the expedition note any adverse weather conditions except cold. Pigafetta says that the ships made daily runs of 50, 60, or 70 leagues. It seems probable that during the first 22 days the expedition may have covered a considerably greater distance than that between 52° and 32° S.

The latitude readings of the Albo log are suspicious throughout. They were presumably obtained from observations of the declination of the sun and from astronomical tables. It is a well known fact that early explorers, even on land, frequently erred by two or more degrees in estimating latitude. Yet the Albo log shows the readings always in sequence with the course sailed and pretends to a daily accuracy of within one-third or one-quarter of a degree. Such accuracy could hardly have been attained on the deck of a ship under sail.

[14] Castanheda, *op. cit.*, Book 6, Ch. 8.

San Pablo and Tiburones

In the original sources for Magellan's voyage across the Pacific there is almost as great a difference of opinion in regard to the position of the islands of San Pablo and Tiburones as there is in regard to the point where the expedition turned westward. Some of the accounts speak of San Pablo and Tiburones collectively only, calling them

Table III—Position of San Pablo and Tiburones

	San Pablo	Tiburones
Albo:	Lat. 16¼° S.	Lat. 10⅔° S.
Pigafetta:	Lat. 15° S.	Lat. 9° S. 200 leagues apart
Genoese Pilot:	Lat. 18° or 19° S., more or less	Lat. 13° or 14° S.
Maximilian of Transylvania:	South of Tropic of Capricorn	No distance noted between the islands
Brito:	1600 leagues W–NW of lat. 32° S.	200 leagues W–NW of San Pablo
Peter Martyr:	Unfortunate Isles just north of the equator	
Oviedo:	After passing Tropic of Capricorn. Distance not given and no distinction made between San Pablo and Tiburones. Second account states that in 3 months and 20 days no land was seen.	
Anonymous Portuguese:	Lat. 18° S.	Lat. 14° S., 800 miles from San Pablo
Barros:	Lat. 18° S., 1500 leagues from the strait	Lat. 13° S., 200 leagues NW of San Pablo
Correa:	No notice of San Pablo and Tiburones	
Gómara:	Position not given	Position not given
Santa Cruz:	Lat. 17° S.	Lat. 11° S., 180 leagues NW of San Pablo
Herrera:	30 days' sail after leaving South America in latitude 32° 20′ S. No distinction between San Pablo and Tiburones. Only common name given: Las Desventuradas.	
Argensola:	No mention of the islands San Pablo, Tiburones, or Las Desventuradas	
Castanheda:	No mention of the two islands	

"Las Desventuradas" and implying that the islands were near each other. Maximilian of Transylvania places these islands south of the Tropic of Capricorn,[15] whereas Peter Martyr states that they lay near, but north of, the equator.[16] The other authorities differ several degrees among themselves and widely from the positions given by Maximilian and Martyr (Table III). The modern writers who have accepted the route charted from the Albo log have ignored these differences. They have followed the route logged by Albo, apparently because its detail gives it a seeming accuracy not pretended by the others. But other evidence indicates that Magellan did not follow this route.

[15] Maximilian of Transylvania, *op. cit.*, Alderley's edit., p. 197; Stevens' edit., p. 126.
[16] Martyr, *op. cit.*, Dec. V, Book 7 (Vol. 2, pp. 156–157).

Directions and Distance Sailed

The compass bearings in all the accounts of the expedition are open to question. Pigafetta[17] tells us that when Magellan asked the pilots

> whether they were always sailing forward in the course which we had laid down on the maps, all replied: "By your course exactly as laid down." He answered them that they [the compass needles?] were pointing wrongly—which was a fact—and that it would be fitting to adjust the needle of navigation, for it was not receiving so much force from its side.[18]

The Genoese pilot[19] says that their needles varied almost two fourths to the northwest. The compass used was apparently similar to one pictured by Alonso de Santa Cruz in the "Islario General"[20] as a 16-point compass with subdivisions halfway between each point. The subdivisions were called "fourths" or "quarters" and equaled 11¼ degrees each. A declination of almost two fourths would be about 22 degrees. In the log of the Loaysa voyage by Hernando de la Torre, under date of June 20, 1526, is the following statement:

> We made way to the northwest, quarter to the west, and we went 13 leagues; and up to here no account has been given of the northwesting of the compass which now varies more than a quarter to the northwest.[21]

Must not the declination of the compass be considered in connection with Magellan's route? If so, it would differ in amount with the locality.[22] A correction of two quarters, which is the declination reported by the Genoese pilot, would change the west-northwest course as plotted from Albo into a northwest course, and this would cause the route to cross the equator at about longitude 115° W., instead of at about longitude 165°, as Albo would have it. This is granting a departure from the vicinity of the South American coast in latitude 32° S.

Albo seldom gives any estimate of distances sailed. The distances, however, can be roughly checked from the latitude, except where the route lay straight to the west. For any sailing between west and north the sailing distance for a day would be approximately the hypotenuse of a right-angled triangle in which the lengths of the two other sides are known. For example, according to the log, on December 19

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[17] Pigafetta, Magellan's Voyage, Vol. 1, p. 89.

[18] The meaning of this passage is obscure. Purchas says that it was necessary to help the compass "Needle with the Load-stone, before they could sayle therewith, because it moved not, as it doth when it is in these our parts" (Samuel Purchas: Hakluytus Posthumus, or Purchas His Pilgrimes, 20 vols., Glasgow, 1905–1907; reference in Vol. 2, p. 92).

[19] Alderley, *op. cit.*, p. 9.

[20] Santa Cruz, *op. cit.*, Vol. 60, pp. 46–49.

[21] Navarrete, *op. cit.*, Vol. 5, p. 271.

[22] It is not possible to locate the area where Pigafetta speaks of the compass variation. With the variation mentioned by the Genoese pilot, the area was between the strait and San Pablo, with an inference possible that the variation mentioned was noticed soon after entering the Pacific. The Loaysa log would place the area of one-quarter variation at about latitude 30° S.

they were sailing northwest and were at latitude 32¾° S., and on December 20 they were still sailing northwest and were at latitude 31¾° S., giving a distance for the 24 hours of about 98 English statute miles. Similar computations yield 49 miles for February 1–2 and 73½ miles for February 14–15. These distances, however, which are characteristic of the Albo log, and Pigafetta's statement that the expedition daily logged 50, 60, or 70 leagues[23] do not at all correspond. Fifty leagues would be 200 Italian nautical miles, or 184 English statute miles; 70 leagues would be 278 statute miles—much more than Albo's distances. The course as described by the Albo log measures almost 13,000 English miles. To have traversed the distance in 103 sailing days would have required a daily average of about 125 statute miles.

Owing to the due-west courses, we cannot estimate the total distance as logged by Albo between the Strait of Magellan and the Philippines, but we do have a statement by him that the two places were 106° 30′ from each other. If his degrees are equal to ours and this statement is taken in its most liberal sense to mean 106° 30′ actual difference in longitude instead of 106° 30′ sailing distance, only 8500 miles would have been covered in the generally west-northwestward course described in the log. This would place the Philippines 10° east of the Marshall Islands (see Fig. 1). On the course as usually plotted, however, the actual distance between the strait and the Philippines is almost 13,000 English statute miles, or over 14,000 Italian nautical miles. This corresponds more nearly with Pigafetta's estimated distance of 4000 leagues, or 16,000 Italian nautical miles.

Magellan's Route in Relation to Asia and America

Certain geographical conceptions that prevailed at the time of Magellan's voyage may well account for his having taken the route that has been suggested in the foregoing paragraphs. Two problems are involved: (1) the relationship of America to Asia; (2) the size of the earth and consequent width of the Pacific Ocean.

That the belief was universal that America formed a new continent separate from Asia and about midway between Europe and Asia has been assumed in recent years by many scholars on the authority of Harrisse and others. The existence of maps of the Waldseemüller type has been cited in support of this view. In a recent publication the writer has pointed out how unscholarly and uncritical it is to endeavor to prove the nonexistence of one belief by citing different beliefs.[24] The fact that a majority, perhaps, of the intelligent people of western Europe between 1492 and 1520 thought that America was

[23] Pigafetta, Magellan's Voyage, Vol. 1, p. 85.

[24] G. E. Nunn: The Columbus and Magellan Concepts of South American Geography, Glenside, 1932, pp. 26–27.

not Asia can never be made to prove that other people did not think that America *was* Asia. In the same publication the writer has traced the belief, persisting for many years after the original discovery, that America was a part of Asia and has shown that Magellan shared in this theory and considered South America to be a peninsula of Asia. The course of Magellan's expedition, even as ordinarily charted, is evidence of this.

In 1520, as far as Europe and Asia are concerned, the concept of geography laid down on Behaim's globe of 1492 was generally accepted.[25] Behaim had drawn a great peninsula extending from southeastern Asia far south of the equator. To the west of this peninsula he had placed the Sinus Magnus, or Great Gulf, of Ptolemy. This gulf was a branch of the Indian Ocean—for in Behaim's view of the world there were only two oceans, the Atlantic and the Indian.

At the time of Magellan's voyage doubt still existed about the identity of the newly discovered transatlantic lands. The followers of Columbus, including Las Casas,[26] had not abandoned the belief that the two Americas were a part of eastern Asia, but Waldseemüller's followers thought that Behaim's eastern Asia lay to the west of the Americas. Although both groups accepted the general outlines of Behaim's east-Asiatic geography, the Columbians identified eastern Asia with the new discoveries, whereas the adherents of Waldseemüller separated these from eastern Asia by a stretch of ocean.

These two divergent opinions have critical bearing upon Magellan's route. The Moluccas, or Spice Islands, for which he was seeking, were believed to lie in the Sinus Magnus about 2000 Italian miles, or 500 leagues, east of Malacca.[27] Had Magellan accepted the opinion of Waldseemüller, after entering the Pacific he would have thought that it was still necessary to sail around the end of Behaim's southeastern peninsula of Asia in order to enter the Sinus Magnus and reach the Spice Islands. Hence he undoubtedly would have sailed westward either from the strait itself or from a point not far north of the strait, so as to gain the southernmost tip of the peninsula by the most direct route. In fact, however, Magellan accepted the theory of Columbus and Balboa, in which the Sinus Magnus and the Pacific Ocean were one and the same.[28] Balboa called the Pacific "la otra mar," or the other sea, by contrast with the Atlantic, evidently with Behaim's concept of only two oceans in mind.[29] Positive evidence that Magellan held the view that the Sinus Magnus and the Pacific were one and the

[25] Santa Cruz, *op. cit.*, Vol. 60, p. 9; Oviedo, *op. cit.*, Book 20, Ch. 2 (Part 2, Vol. 1, p. 22).

[26] Bartolomè de las Casas: Historia de las Indias, 5 vols., Madrid, 1875–1876, Vol. 2, p. 204, and Vol. 5, pp. 371–376; see also Vol. 1, pp. 279, 315, and 361, and Vol. 5, pp. 328–329 and 513.

[27] Alderley, *op. cit.*, p. 32. For another view of the distance see Navarrete, *op. cit.*, Vol. 4, p. 351.

[28] Nunn, *op. cit.*

[29] Angel de Altolaguirre y Duvale: Vasco Nuñez de Balboa, Madrid, 1914. Carta de Vasco Nuñez al Rey, etc., pp. 16 (1), 19 (4), 20 (2), 21 (1). Figures in parentheses indicate number of times expression "la otra mar" is used.

same and that South America was a part of Asia is furnished by the Alvarez letter of July 18, 1519.[30] According to this letter, the map of the Reinels, father and son, used by Magellan, showed no land between Cabo Frio, at the western entrance to the Strait of Magellan, and the

TABLE IV—SUPPOSED LOCATION OF THE SPICE ISLANDS

(Longitudes calculated from Cape Verde)

	Spice Islands (E. long.)	Isthmus of Panama[b] (W. long.)	Degrees from Panama east to Spice Islands	Degrees from Panama west to Spice Islands	Distance in Italian nautical miles from Panama west to Spice Islands
Portuguese claims[a]	133° or 129°	92°	225° or 221°	135° or 139°	9450
	(Degrees calculated at 70 Italian nautical miles per degree)[c]				
Magellan[d]	152°	104°	256°	104°	6500
	(Degrees calculated at 62½ Italian nautical miles per degree)				
Spanish claim at Congress of Badajoz, 1524[e]	178°	104°	282°	78°	4875
	(Degrees calculated at 62½ Italian nautical miles per degree)				
Columbus[f]	230°	115°	345°	15°	850
	(Degrees calculated at 56 ¾ Italian nautical miles per degree)				

[a] M. F. de Navarrete, Coleccion, Vol. 4, pp. 366–367.
[b] Peter Martyr, De Orbe Novo, MacNutt's edition, Vol. 1, pp. 272–273.
[c] Navarrete, *op. cit.*, Vol. 4, p. 352.
[d] *Ibid.*, pp. 188–189 and 366. 184°–32° distance Line of Demarcation to C. Verde.
[e] *Ibid.*, p. 354. The Spanish estimated 32° from the Line of Demarcation to Cape Verde (*ibid.*, p. 340).
[f] F. R. von Wieser: Die Karte des Bartolomeo Colombo . . . , *Mitt. Inst. für Österreichische Geschichtsforschung, Ergänzungsband 4*, Innsbruck, 1893; also R. H. Major, transl. and edit.: Select Letters of Christopher Columbus, 2nd edit., *Hakluyt Soc. Publs.*, Ser. 1, Vol. 43, London, 1870, p. 183.
[g] Calculated to Retrete on the Isthmus of Panama.
[h] At the Congress of Badajoz. The Spanish delegates supposed that Cabo Verde, Cabo Blanco, Madeira, and the middle between Gran Canaria and Teneriffe were all under one meridian (see Navarrete, *op. cit.*, Vol. 4, p. 350).

Moluccas. If Magellan held to such an opinion, with but the vaguest notion at best where the Spice Islands lay, obviously his only certain course was first to seek and reach the neighborhood of the equator as soon as possible and then to follow it west until his goal was gained.

Such a route is in accord with the known plans of the Spanish government in the case of the proposed expedition of Juan Días de Solís in 1515–1516.[31] Indeed, there is a considerable body of evidence showing that before Magellan's voyage many persons, including Balboa, believed that the Spice Islands lay immediately west of Panama,[32] and Magellan himself subscribed to this view.

Magellan told Don Juan Rodríguez de Fonseca, President of the Royal Council of the Indies in Castille and [told] to the same Council that, By the seas of Brazil and the Rio de la Plata there is a shorter passage to the Spice Islands than by the Cape of Good Hope and in addition to Sumatra and Malacca and many other oriental

[30] Navarrete, *op. cit.*, Vol. 4, pp. 153–155; reference on p. 155.
[31] Manuel de la Puente y Olea: Los Trabajos Geográficos de la Casa de Contratación, Seville, 1900; reference on pp. 151–155.
[32] The present writer has been engaged for several years on a work dealing with Balboa's discovery. Here evidence is assembled to prove that Balboa and many of his contemporaries expected to find the Spice Islands immediately west of Panama.

lands falling in the portion of Castille, the Moluccas are not very distant from Panama and the Gulf of San Miguel.[33]

It was because the Spice Islands were supposed to lie immediately west of the Isthmus of Panama that the crossing of the isthmus was deemed so important.

The conclusion that the great German geographer Johann Schöner drew from Magellan's voyage was that South America was a peninsula of Asia and that North America was eastern Asia. These views he set forth on his globe of 1523 and in his "Opusculum Geographicum." Magellan's circumnavigation had proved that only one great peninsula besides Africa extended far into the southern hemisphere. Therefore, since it was taken for granted that there was a great peninsula extending from southeastern Asia far into the southern hemisphere, South America was accepted as that Asiatic peninsula. Magellan's voyage resolved for Johann Schöner the conflict between the Columbian and Waldseemüller views. The course of Magellan's fleet to the north from the strait indicates that Magellan had accepted the Columbian view before he started to cross the Pacific.[34]

The Width of the Pacific Ocean

Magellan's ideas regarding the location of the Spice Islands were vague because the size of the earth was unknown in his time and differences of opinion consequently prevailed in regard to the width of the Pacific and the longitude of the islands. By analyzing the available data in the manner shown in Table IV we find that there was a wide variation of opinion in regard to the water distance between the Spice Islands and the Isthmus of Panama. According to the followers of Columbus it was only a short distance from the isthmus to the Spice Islands. The Portuguese made the distance about one-third that around the world. Even after the voyage of Magellan the Spanish delegates at the Congress of Badajoz based their contentions substantially on Ptolemy's estimate of the size of the earth. In view of these differences of opinion, it is only fair to declare that the location of the Spice Islands with regard to America was unknown. In the light of this uncertainty it is altogether unlikely that Magellan would have directed his course away from the coast of America as soon as the Albo log implies. The only certainty in the circumstances would have been to seek the equator and then go westward in its near vicinity until the Spice Islands were reached. This course would permit the

[33] Esteban de Garibay y Zamalloa: Compendio historial de las Cronicas y universal historia de todos los Reynos d'España, 2 vols., Antwerp, 1571, Book 35, Ch. 31 (pp. 916–917); Gómara, *op. cit.*, Ch. 91 (Vol. 1, pp. 214–215).

[34] Johann Schöner: Opusculum Geographicum, quoted in Henry Harrisse: The Discovery of North America, London and Paris, 1892, pp. 524–525; F. C. Wieder, edit.: Monumenta Cartographica, Vol. 1, The Hague, 1925; G. E. Nunn: The Lost Globe Gores of Johann Schöner, 1523–1524, *Geogr. Rev.*, Vol. 17, 1927, pp. 476–480.

discovery of the islands no matter what the distance might be and would obviate the danger of passing the islands unwittingly and falling into the hands of the Portuguese in India.

Cipangu and the Islands of Gold and Silver

Pigafetta wrote incidentally that the expedition sailed "a short distance from two exceedingly rich islands, one in twenty degrees of the latitude of the Antarctic Pole, by name Cipangu, and the other in fifteen degrees, by name Sumbdit Pradit."[35] It is, of course, not true that Cipangu was in the southern hemisphere.[36] Cipangu was placed on the Waldseemüller map of 1507 and others of its type so that its eastern side backed against the 270th meridian east of the Canaries. This would place it about 25 degrees west of the city of Panama. If Magellan passed near Cipangu as thus located, he must have approached the coast of Mexico to the west of Acapulco.

The Loaysa expedition of 1525–1526,[37] which was piloted by Sebastian del Cano and certainly must have followed approximately the track of Magellan, also sought the island of Cipangu. The route according to Hernando de la Torre's log of the Loaysa expedition has been plotted on Figure 1 for comparison with the route according to Albo's log of the Magellan expedition. La Torre speaks of the compass variation[38] in the Pacific and underlogs the distance to the Ladrones about 25 degrees. The route has been corrected for compass variation, using a correction of 11¼ degrees between the Strait of Magellan and latitude 20° S. This correction, which makes no pretense to accuracy because the data are too limited, shows the possibility that the Loaysa expedition may have sailed in the near vicinity of the place where Waldseemüller placed Cipangu. Andres de Urdaneta wrote[39] that the Loaysa expedition abandoned the search for Cipangu after going north to latitude 14° or 15° N. This abandonment took place on the ninth of August according to the log of La Torre, although the latter does not mention Cipangu.

Further evidence that the Loaysa expedition sailed near Waldseemüller's Cipangu is the fact that Santiago de Guevara, the com-

[35] Pigafetta, Magellan's Voyage, Vol. 1, pp. 89 and 91. Robertson suggests (*ibid.*, p. 247, note 177) that Sumbdit Pradit may have been the island of Antilia, called "Septe citade" on Martin Behaim's globe. It seems more likely that Sumbdit Pradit is the same as the legendary islands of Khryse and Argyre, or the islands of gold and silver. *Prad-a* (*prata*) means silver in Malay (John Crawfurd: A Grammar and Dictionary of the Malay Language, 2 vols., London, 1852, Vol. 2, p. 142). The story of the two islands was derived originally from Hindu literature. Al-Biruni (1031 A. D.) speaks of the island of gold, Surendib, or the Suvarna-dvīpa of Sanskrit literature. Sumbdit Pradit might well represent a combination of Surendib and Pradit (*prada*). See G. E. Gerini: Researches on Ptolemy's Geography of Eastern Asia . . . , *Asiatic Soc. Monographs No. 1*, London, 1909, pp. 568 and 670–672.

[36] An island named Cimpegu and another named Sumhedit were placed between latitudes 10° and 20° S. in the Pacific on a large map of 1569 of Joan Franciscus Camotius (See "A Large Map Dated 1569 By Joan Franciscus Camotius: Now in the George H. Beans Library," Philadelphia, 1933).

[37] Navarrete, *op. cit.*, Vol. 5, pp. 241–313.

[38] Navarrete, *op. cit.*, Vol. 5, pp. 269 and 271.

[39] Navarrete, *op. cit.*, Vol. 5, p. 407.

mander of the *patache* in the Loaysa expedition, reached Salina Cruz in Mexico. He was separated from the fleet of Loaysa by a storm on June 1, 1526. He almost certainly sailed in the same general direction as the rest of the fleet, because it was customary for the commander to assign some general rendezvous in terms of either direction or place in case his boats should become separated. En route Guevara saw many birds of various kinds.[40] He could not have gone very far west of the meridian of Salina Cruz, because the wind conditions were such as to have made difficult an eastward course to reach that place (see Fig. 1). Of course the significance of the voyages of Loaysa and Guevara, as far as their relation to the voyage of Magellan is concerned, depends on the assumption that Sebastian del Cano was following the route of Magellan.

Conclusions

The foregoing analysis of the various contemporary accounts of Magellan's voyage reveals a most marked discrepancy in regard to (1) the latitude in which the expedition left the vicinity of the coast of South America, (2) the latitude of San Pablo and Tiburones, (3) the direction sailed, and (4) the distance traversed in the Pacific between the Strait of Magellan and the Philippines. Since these discrepancies come from the men who took part in the expedition, they suggest a purpose to deceive.

The motive that at once suggests itself is the determination of Magellan to claim possession of the Spice Islands. The exceedingly great distance across the Pacific revealed the strong probability that the Spice Islands were within the Portuguese half of the world. If the log of Magellan's voyage were to admit that the Spice Islands fell within the Portuguese sphere, the rights of Magellan in the Spice Islands would have been nonexistent and the expenditures of Magellan and his friends would have been in vain, according to the grant of the emperor Charles V.[41] Even after the sale of the Spice Islands to the Portuguese the Spanish retained their claim to the Philippines. Therefore there was always a motive for the early Spanish writers on this subject to deceive their public.

The Portuguese historian João de Barros knew that the Spanish accounts were arranged to make the Spice Islands seem to fall within the Spanish half of the world. He writes that one of the Spanish followers of Magellan, Bustamente, on his deathbed in the Maldive Islands, in order to clear his conscience testified that certain alleged facts concerning Magellan's voyage were contrary to the truth. He said the longitude of Rio de S. Julião (on the east coast of Patagonia)

[40] Oviedo, *op. cit.*, Book 20, Ch. 12 (Part 2, Vol. 1, p. 50).
[41] Navarrete, *op. cit.*, Vol. 4, pp. 116–117.

was 60 degrees west of Seville. He also stated that San Martin located the lands met in Magellan's voyage according to Spanish interests rather than according to fact and Portuguese interests.[42] Castanheda also accuses the Spanish of falsifying the latitude of Port San Julian in order to shorten the accredited distance to the Spice Islands.[43]

When the false account of the route and of the distance traversed by Magellan's fleet was drawn up certain facts were unknown, other facts ignored, and some facts that betray the deception inadvertently admitted. (1) At the time that the original accounts were written it was unknown that the South Pacific near the route of Magellan's expedition as logged by Francisco Albo is filled with innumerable small islands easily located by bird flights. (2) The only precise information in Magellan's day concerning the location of the Spice Islands was that they lay near the equator. (3) The width of the Pacific was unknown. (4) There was only one certain way of locating the Spice Islands from the east. This was to go north from the Strait of Magellan to the equator and then to proceed west on or near the equator until the Spice Islands were found. (5) In sailing northwestward from the strait the voyager would run the risk of missing the Spice Islands and falling into the hands of the Portuguese in India—something Magellan would hardly have desired to happen. (6) An incidental remark made by Pigafetta concerning the island of Cipangu reveals the true course of the fleet and the nature of the deception. (7) The fleet approached latitude 20° N. in the area where some geographers supposed Cipangu to be located. (8) The latitude of Cipangu was altered to read 20° S. (9) Likewise the latitude of San Pablo and Tiburones was altered to south latitude. (10) The purpose of this alteration was to give a northwest traversal of the Pacific instead of an east-west traversal. This would give a plausibility to the estimated width of the Pacific that could not be claimed in an east-west traverse. (11) The most approved method of determining longitude in Magellan's time[44] was to sail a course between east-west and north-south. Observations of latitude then made possible a determination of the distance sailed. (12) This method was one of those proposed at the Congress of Badajoz in 1524 to determine the location of the Line of Demarcation in the east. (13) If only a slight correction in the direction of the course as given by Albo is made for compass variation, the route of Magellan would miss entirely all the islands of the South Pacific. (14) The Albo log was compiled after Magellan reached the Philippines. (15) Its purpose was to make the Spice Islands seem to fall within the Spanish half of the world. (16) In the same way and for the same purpose the log

[42] Barros, *op. cit.*, Dec. III, Book 5, Ch. 10 (Vol. 5, pp. 659–662).

[43] Castanheda, *op. cit.*, Book 6, Ch. 7.

[44] Navarrete, *op. cit.*, Vol. 4, pp. 336–337.

of the Loaysa expedition underestimated the distance across the Pacific to the Ladrones by 25 degrees. (17) The same error or deceit exists in the log of the Saavedra expedition of 1527–1528 (see Fig. 1). (18) If the compass variation is taken into account, the Albo log and the log of the Loaysa expedition both underestimated the distance to the Ladrones by 55 degrees.

In view of these facts the writer contends that the true course of Magellan's expedition was parallel to the coast of South America probably as far north as the 20th parallel of south latitude. Then the direction was altered to northwest, largely because Magellan did not care to go near the Spanish on the Isthmus of Panama after the trouble at Port San Julian. San Pablo and Tiburones may be identified with Clipperton and Clarion islands, in latitudes 10° 17′ N. and 18° N. respectively, or approximately the reverse of the latitudes given in several of the accounts. These conclusions are supported by the corrected course of the Loaysa expedition as logged by Hernando de la Torre and by the report of the voyage of the same expedition by Andres de Urdaneta, and by the assumption that the pilot Sebastian del Cano was following the route of Magellan. Finally, considering the apparent discrepancies involved in the various Spanish accounts of Magellan's expedition, more reliance should be placed in the João de Barros and Fernão Lopes de Castanheda variations from the Spanish accounts, especially in view of the inadvertent admission by Pigafetta that the expedition passed near the island of Cipangu.

IS THE POPULATION OF THE UNITED STATES NOW DECREASING?

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IN the United States children under three years of age were fewer in 1930 than in 1920. Presumably the country is somewhere near that transition stage of population growth in which it is difficult to observe the moment when growth gives place to decline. The moment is geographically interesting because the transition is from an exuberant, expanding environment, with numbers, markets, values, and opportunities all growing so vigorously that talk about prudence, economy, and thrift is frowned on, to an environment of contracting numbers, markets, and values, when thrift must be appealed to if standards attained are not to be abandoned. Where is the United States at the present moment?

The falling off in numbers of an age class of our population is new. It may be the first visible sign of a falling off in our total population that is generally regarded as impending. The Scripps Foundation estimates that we shall reach our maximum number before 1940. Ever since the Civil War our population has had a decennial increase of more than ten million people: in the World War decade it was sixteen million, in the last decade seventeen million. But the percentage increase has been declining steadily and strongly decade by decade. From a little more than 35 per cent in each of the first seven decades it has fallen to less than 16 per cent.

Movement of Population by Age Groups

Different age groups of the population do not increase at the same rate. All the groups increased in numbers until 1920; from that year the group under five and that under one year lost. The loss in the former is attributable to those under one and the one-year-olds and the two-year-olds.

Of the whole population, those under 15 constituted 34.4 per cent in 1900, 32.1 per cent in 1910, 31.8 per cent in 1920, and 29.4 per cent in 1930: in 1850 the proportion had been 44.1 per cent. Children form a distinctly smaller part of the people than they used to. The youngest group, those under one year, formed successively 2.6, 2.4, 2.1, and 1.8 per cent of the population. The percentages added in each decade, as given in Table I, are most instructive. The oldest age group added 13.4, 14.4, and 6.3 per cent in the three decades; the youngest group, the children under one, added 15 per cent and 2 per cent and then *lost* 3 per cent.

Effect of Immigration Check

Although the mortality is now small, births are falling off faster. Immigration has been checked by statute and by momentary unprosperity. Since the autumn of 1930 more aliens have left the country every month than have come to it.

At first sight it would seem that immigration could have little

Table I—Younger Age Groups (in thousands) and Percentage Increases

	Under 15	%	Under 10	%	Under 5	%	Under 1	%
1900	25,911		18,045		9,171		1,917	
		13.4		13		16		15
1910	29,392		20,392		10,631		2,217	
		14.4		12.6		9		2
1920	33,614		22,971		11,573		2,257	
		6.3		4.5		-1		-3
1930	35,974		24,051		11,444		2,191	

effect on the number of children under three. The fact is, however, that the loss in young children is noted only in foreign-born children and children of the foreign born (5345 foreign-born whites, 474,685 native whites of foreign parentage, and 22,681 "other races"). The reduced numbers are not caused by the birth of fewer children in American families of native stock, white or black. In the group under age three, native white children[1] of native parentage were 250,771 more in number in 1930 than in 1920, negro children 43,342 more. The decennial increase for the whites was 5.6 per cent, for the negroes 6.5 per cent. On the other hand, the native white children of foreign parentage fell off 27 per cent; the foreign-born and "other races" children, about 50 per cent. It is evident that a change in the class of immigrants or in immigration laws might yet check the loss of population observed.

Geographical Distribution

In the United States as a whole children under three were 207,950 fewer in 1930 than in 1920, but this is not true all over the country. Michigan had thirty thousand more children under three in 1930 than in 1920, California eighty thousand more. The states shaded on the map, Figure 1, gained 208,838; the unshaded states lost, to the number of 416,436 with a net loss to the country of 207,598.

The census specifically disclaims accuracy in reporting children in single-year age groups. The facts are not at present ascertainable.

[1] The census of 1920 included Mexicans under whites, that of 1930 listed them separately. To make the two enumerations comparable I have added the Mexicans in the 1930 figures to the whites and subtracted them from "other races," which gives different figures for "native whites of foreign parentage" and "foreign-born whites" and "other races" from those printed in the census reports.

Children under five are believed to be underenumerated, but "the underenumeration of children is not peculiar to the United States census."[2] Here an odd item is noted. "On the other hand, the enumeration of native white children of foreign parentage appears to be practically complete." This is precisely the group that shows practically all the falling off in children under three years. For the white children of native parentage complete count is not claimed. These are the children who have *increased* in number in the last ten years.

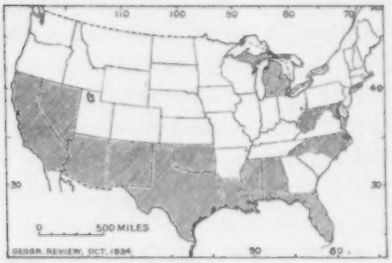

FIG. 1—Loss and gain in children under three years of age at the 1930 census: states showing loss are unshaded; states showing gain are shaded.

It is familiar that the ragged edges of the diagrams of age distribution by single years[3] are due to inaccuracy of the reported ages. But a smooth curve may be drawn through the ragged edges at each side of the diagram that will give a close rendering of the real facts. If the lower ages were understated in 1930, so they were doubtless for 1920, as the diagrams agree closely. Finally, the results here brought out are too systematic to be merely the outcome of casual mistakes in census enumeration. From the smoothed curves we may estimate the population loss from 1920 to 1930 at 10,000 two-year-olds, 60,000 one-year-olds, and 160,000 under one year.

The percentage of the whole group of native whites of native parentage that were under age three in 1920 was 7.6; in 1930, 6.7. Among the negroes, 6.3 per cent were under three in 1920 and 5.95 in 1930. But barely a third of one per cent of the foreign born and "other races" were under three in 1920 and not quite a fifth of one per cent in 1930, which accentuates the childlessness of the present immigrants. But among the native whites with a foreign parent 7.6 per cent were under three in 1920, which dropped to 4.8 per cent in 1930. In 1920 the percentage for whites under three was precisely the same for native and for foreign parentage, but it fell to a point a third lower for the children of foreigners than for those of native parentage.

Indeed, in the class of native children of foreign parents a falling off of children under one year began twenty years ago. They numbered 579,730 in 1910; 559,794 in 1920; and 345,962 in 1930—losses of 20,000 and 213,000 respectively for the two decades.

The census prefers to report children in five-year age groups because

[2] Fifteenth Census of the United States: 1930: Population, Vol. 2, U. S. Dept. of Commerce, Bur. of the Census, Washington, 1933, p. 566.

[3] *Ibid.*, p. 571.

of the admitted inaccuracy of the lower age enumeration. The percentages of increase for the last four decades for all children under five are: native whites of native parents, 20, 19.8, 12.5, and 7.8 per cent; native whites of foreign parents, 24, 11, 11, and −34 per cent.

This represents a loss in population in a way, but it is a gain in native as against foreign stock.

TABLE II—POPULATION CLASSES AT THE 1930 AND 1920 CENSUSES

	ALL AGES		UNDER THREE YEARS OF AGE	
	1930	1920	1930	1920
All classes	122,775,046	105,710,820	6,681,372	6,888,970
Nat. Wh. of Nat. Par.	70,136,614	58,421,957	4,687,765	4,436,994
Nat. Wh. of For. Par.	26,166,721	22,636,204	1,259,026	1,733,711
Foreign-born Wh.	13,983,405	13,712,754	14,362	19,707
Negroes	11,891,143	10,463,131	707,499	664,157
Other races	587,163	426,574	12,720	34,401

AN EARLY ACCOUNT OF BERING'S VOYAGES

Leonhard Stejneger
U. S. National Museum

WHEN the first news of the discovery of Alaska by Bering and Chirikov reached Russia in 1742 and 1743 only the bare facts of the shipwreck and death of the former and the return of the latter were allowed to leak out into the periodical press of contemporary Europe, with the result that very few people outside the government in St. Petersburg were in a position to evaluate properly Professor J. N. Delisle's pretensions of 1752 in his "Nouvelles découvertes au nord de la Mer du Sud" and his curiously garbled account of Bering's expedition. Some of the facts were made known the following year, eleven years after the event, in the celebrated pamphlet "Lettre d'un officier de la marine russienne," the authorship of which has been brilliantly and convincingly traced by General A. W. Greely[1] to Lieutenant Sven Waxell, second in command under Bering on the *St. Peter*. The history of the expedition was still further elaborated in Gerhard Friedrich Müller's "Nachrichten von Seereisen."[2]

Since then several more or less detailed accounts of these expeditions have been published, but until the appearance in 1922 of the first volume of Golder's "Bering's Voyages"[3] very few of the original documents had been available to the public even in the Russian language. It is therefore highly interesting to find that the first official and circumstantial account of Bering's American voyage, during which he discovered Alaska, was published in a Danish translation as early as 1747, viz. Waxell's original report of November 15, 1742, sent to the Russian Admiralty College immediately after the return from the disastrous wintering on the island where Bering, the leader of the expedition, and many of his followers lost their lives.

Peder von Haven was a young Danish theologian who visited Russia during the years 1736 to 1739 as Admiral Bredal's secretary and later as private tutor in General Repnin's family. After his return to Copenhagen he published an account of his voyage, which the following year was translated into German under the title "Reise in Russland" (Copenhagen, 1744). In 1744 he had another opportunity to go to Russia, this time as chaplain attached to the staff of the Danish ambassador, Karl von Holstein. On this visit he met his countryman, Captain Morten Spangberg, Bering's lieutenant, who told him about his own discoveries in the Kurile Islands and in Japan. It is safe to assume that Von Haven also obtained from Spangberg most of his other information about Bering's expeditions, including the Waxell report.

On his return to Copenhagen early in 1747 Von Haven published a two-volume octavo (6¾ inches high x 4 inches wide) with the following title:

> P. v. Havens / M. Ph. og d.h. Ev. T. / Nye og forbedrede / Efterræt- / ninger / Om / Det Russiske / Rige / efter nöyere Kundskab / Som han har indsamlet paa hans / Sidste Reyse. / - Förste [Anden] Deel. / - Kiöbenhavn, Aar 1747. / Trykt paa Autors egen Bekostning. (Vol. 1 - [xii] + 548 pp.; vol. 2 - 533 pp. + Register [xv pp.])

The entire third chapter of the second volume (pp. 17–43) is devoted to "Efterretninger om Capitein Commandör Bierings og Capitein Spangenbergs Reyser fra Kamskiatka." Its importance lies in the fact that it is the first authentic account of

[1] The Cartography and Observations of Bering's First Voyage, *Natl. Geogr. Mag.*, Vol. 3, 1891–1892, pp. 205–230; reference on pp. 222–229.

[2] Nachrichten von Seereisen, und zur See gemachten Entdeckungen . . . , *in* Sammlung Russischer Geschichte, Vol. 3, St. Petersburg, 1758, pp. 1–304.

[3] F. A. Golder: Bering's Voyages, Vol. 1, *Amer. Geogr. Soc. Research Ser. No. 1*, 1922.

Bering's second expedition given to the Western world. It is further remarkable, not only for being the first attempt at a complete review of the two Bering expeditions and the circumstances leading up to them, but, considering the times, for its relative accuracy and comprehensiveness. It therefore occupies a prominent place among the publications dealing with that stupendous geographical enterprise and deserves to be made available to students in its entirety. A fairly literal translation follows.

THE THIRD ARTICLE
containing
an account of the voyages of Captain-
Commander Biering and Captain
Spangenberg from Kamchatka.

While treating of my own travels among Cossacks and Kalmucks, there comes to mind a much more arduous voyage that two of my countrymen from northern Jutland, Captain-Commander Biering,[4] born in Horsens, and Captain Morten Spangenberg,[5] born near Varde in a village called Jerned, were undertaking for the second time during the same years [as the author's own] through Siberia to Kamchatka[6] and farther east. Inasmuch as this voyage has attracted much attention without having been properly reported to the world, [p. 18] I intend here to describe it from beginning to end.

In the chapter on the Siberian Commerce[7] I have already shown the condition of the country under Tsar Ivan Vasiloviz the Great—how the feeble natives were being brought under tribute gradually farther and farther east. Thus the Russian Empire was extended until the discovery of Kamchatka under Tsar Alexius Michaloviz, the father of Emperor Peter the Great. This country is a peninsula, the easternmost and farthest part of Siberia and Tatary along the Pacific Ocean which separates Asia from America. The wretched inhabitants, who live in even greater misery than the Kalmucks, as well as all the other Siberian nations, according to their own account, were compelled some hundred years before to flee north over the mountains.

Emperor Peter I, who during his long rule had collected information about Kamchatka, [p. 19] as soon as he had secured peace with all his enemies abroad and had completed the most necessary reforms at home, began to give attention to this corner of his empire in order to win glory by exploring its condition. He therefore on February[8] 8, 1725, shortly before his death, issued an order, the last one he signed personally, by which Captain, afterwards Captain-Commander, Biering and Lieutenant, later Captain-Lieutenant and now Captain, Morten Spangenberg, two Danes in the Russian service, together with various Russians and foreigners as ship carpenters, students, etc., were to proceed immediately to Kamchatka by way of Siberia. They were everywhere to be supplied with everything necessary for their expedition and were to make note of all novelties encountered and to examine, particularly at the Ocean, into the situation of Kamchatka relative to other countries.

The choice that the Emperor made, of persons suitable for the expedition to Kamchatka [p. 20] was not without reason. But it afterwards became the fashion in Petersburg to send away, to help Biering make the new discoveries, persons whose presence was considered undesirable. A Kurlandian noble of the horse guards at Petersburg who with some others of his countrymen, out of uncalled-for curiosity,

[4] Biering or Bierring is one of the variants of the family name Bering, still borne by a branch of the family in Denmark and the United States. [L.S.]

[5] He himself wrote it Spangberg, but Von Haven's spelling of both names is retained in this translation. [L.S.]

[6] Von Haven writes "Kamskiatka" throughout the book. [L.S.]

[7] Vol. 1, pp. 145–150. [L.S.]

[8] This is an error for January. Peter died on January 28, 1725. [L.S.]

had investigated and published the genealogy of their new Duke,[9] was in this way sent to Kamchatka in 1738 at double salary for the purpose of assisting the naval officers in making the charts of their voyages. I talked with this man in Moscow during 1744 and also, on other occasions, with several persons who have returned from the expedition.

Biering with his companions at once left Russia in 1725 for Tobolsk in Siberia, from Tobolsk to Irkutsk, and under great difficulties from Irkutsk to Yakutsk, a small Siberian town on the river Lena, about 67° north latitude. No road was built from there to [p. 21] Kamchatka; the passage at that time on account of lack of provisions could not be made by more than a few men together, who had to proceed, sometimes on snowshoes, sometimes under other difficulties, at the peril of their life. The captain, therefore, left part of his command in Yakutsk and continued with only the most necessary men and supplies to the place where the river Okhota debouches into the Gulf[10] of the Pacific Ocean which separates the peninsula of Kamchatka from the mainland of Siberia.

At this place he awaited the arrival of more supplies from Yakutsk, in the meantime occupied not only with building a small ship but also with establishing lodgings, planting seeds and grains, and making other arrangements for feeding and housing the men. From this place, which from the name of the river is called Okhotsk, he sailed in the little vessel, built by him, a thousand versts[11] eastward [p. 22] to Kamchatka, proceeding along the land, everywhere closely investigating the natives and continuing his cruise until reaching latitude 67° N. At this degree he found no land farther towards the north but would have to sail through a narrow passage between the highest icebergs of the sea before he could get around the northeastern cape of Siberia, where the northeastern Siberians sometimes hunt and fish during the summer. However, all these people asserted with one accord that such a voyage from the land of the Samoyeds near Arkhangelsk around the Cape down to Kamchatka had really been made by wayfaring people, most of whom had lost their life during the voyage, and those who survived, their health. Biering, whose orders were, when faced by evident peril, to save himself and his crew as best he could, therefore sailed back and arrived at the harbor in Kamchatka, where he stayed near a river during the winter [p. 23] in order to repair his vessel. From here he proceeded on June 5 the following year, southwards to the end of the country [Cape Lopatka] and thence west-northwest up in the Gulf [Sea of Okhotsk], until he finally arrived in Okhotsk on July 23 after a cruise of seven weeks.

From Okhotsk he returned to Moscow, where he delivered his journal, kept according to maritime usage, together with a chart drawn according to what he himself had seen during the voyage or heard reliably narrated by others. The circumstances that had prevented him from making further discoveries he reported orally, such as lack of lumber suitable for ships, able men, especially experienced mariners, etc. These causes were remedied as far as possible, so that Biering in 1732 [error for 1733] went again to Kamchatka under new orders and with more resources.

Now began in earnest the exploration of everything in Kamchatka and the northeastern parts of Siberia. Efforts were particularly made at building [p. 24] in Okhotsk and in the port in Kamchatka called St. Peter and St. Paul. In Okhotsk two vessels were built that under Captain Spangenberg's command were to go southeast in search of Yezo and Japan. After sailing from Okhotsk a thousand versts across the gulf to Kamchatka there are still 200 versts[12] overland to the port of St. Peter and St. Paul, which is located on the Pacific Ocean opposite America.

[9] Biron, favorite of Empress Anna who in 1737 made him Duke of Kurland. [L.S.]
[10] The Okhotsk Sea. [L.S.]
[11] 580 nautical miles. [L.S.]
[12] 132 statute miles. [L.S.]

Here [at Okhotsk] were also built two vessels, which under the command of Captain-Commander Biering were to search towards the east and north for the American land.

Captain Spangenberg sailed southeast past Yezo and with his two ships came finally to the northern coast of Japan over the unknown sea. He set his course along the land as the wind permitted and anchored now at one place, now at another. He was finally seen by the Japanese, who then collected in big crowds on the [p. 25] beach, shouted vociferously, and sent out several small boats from which the people sold him both provisions and other wares. As he let them know that none of his crew had permission from their government to go ashore anywhere, they rowed back, whereupon a distinguished Japanese with several others came on board the vessel, furnished him with various refreshments, and gave him [articles of] porcelain in exchange for red cloth. Spangenberg thereupon sailed back to Okhotsk and drew a chart of his voyage, which he did not want to communicate to me when a short time ago I spoke with him in Petersburg. He made the further statement that from Kamchatka, Yezo, and Japan there are islands, one close to the other all the way to America, and that these islands, as well as America itself, according to the testimony of the people themselves, have been places of refuge for both Chinese and Japanese for many hundred years.

Captain-Commander Biering had a more trying voyage towards the [p. 26] northeast and on the return stranded on an island near Kamchatka, where he and a large number of the crew died.

The following is the report on his voyage that the survivors sent to the Admiralty Board in Petersburg . . .

Peder von Haven's rendering of Waxell's report of November 15, 1742, from Petropavlovsk, is somewhat condensed but otherwise apparently almost always correctly translated. It corresponds to pages 270–276 of Golder's English translation.[13] As we now have the latter, there is no need of retranslating Von Haven's rendering, but some of the more important discrepancies may be noted, such differences of translation being disregarded as, for instance, "we had to reef" for "we had to heave to."

On page 27 Von Haven makes Bering change the course to E. by N. after reaching latitude 45° 30′ N., while Golder's version on page 271 has 45° 13′, which seems to agree better with the log (p. 70).

On page 29 Von Haven enumerates a pickax (*hakke*) among the things brought on board, where Golder (p. 271) has a "wooden basket," the same as in the log (p. 97).

On page 34 Von Haven records that on "September 4, at 5 o'clock in the afternoon we heard a loud shout of people," while Golder (p. 273) has: ". . . September 4. About noon of the 5th we heard a loud noise." In the log (p. 147) the event is described as taking place in the afternoon between 4 and 5, agreeing with Von Haven's version.

There is a curious transposition of the text relating to the conditions on board the *St. Peter* on November 4 and 5. In Von Haven's account (p. 40) the matter contained in the second paragraph of page 276 of Golder's text down to "Therefore, on November 5" immediately precedes "November 4, on which day we sighted land" at the top of Golder's page 276, and in the text some of the sentences are differently placed. These discrepancies are of interest only as they raise the question whether Von Haven and Golder may not have had different copies of Waxell's report before them.

The last sentence of the Von Haven translation is evidently erroneously rendered. It reads as follows: [p. 42] "Captain-Commander Biering was also taken sick on

[13] *Op. cit.*

the eighth, and Master Kytrov on the fifteenth of November [1741], whereupon both were carried ashore from the vessel," while the correct translation according to Golder (p. 277) is: "We took the sick Captain Commander ashore on November 8; Fleet Master Khitrov, who was also ill, on the 15th."

For one reason or another Von Haven was not given access to the second half of Waxell's report, which treats of the wintering of the *St. Peter's* crew on Bering Island, the building of the new hooker out of the remnants of the stranded packet, and the return of the survivors to Kamchatka in 1742. After the sentence quoted above Von Haven proceeds as follows:

"This report ends here, which after having been correctly translated from Russian is put into a tolerably decent style by me, in order that it may be more easily understood. Like many other readers, I had expected to find in it more discoveries and better accounts of what was really discovered, and I am unable to give further information about various things in it without romancing. What has been told me orally about the end of the voyage is as follows:

"The vessel, which was lying close to the island, was a short time afterwards broken up by the waves during a gale and the pieces thrown ashore, where they were collected by those of the men who were still well and who occupied themselves with caring for the sick. They also wandered about on the island to investigate but found nothing except innumerable foxes, [p. 43] which they ate in order to sustain life until they obtained better tasting food from the large sea cows, which almost daily came on shore out of the sea and on account of their difficult way of walking were easily beaten with poles and caught. In such misery most of the men died, even their commander, Biering. Those who lived through the winter into the year 1742 built during the spring a small vessel of the pieces collected from the old ship, in which they returned to the port of St. Peter and St. Paul, which contrary to their expectation was only twenty [German] miles distant in the west. From here they at once sent in the report above rendered, whereupon a great number of them, as well as of Spangenberg's men, received permission to return to Russia, but the remaining seven or eight persons are still stationed in the little Siberian town of Tomsk until further orders."

THE ICE DAM AND FLOODS OF THE TALSEKWE, BRITISH COLUMBIA

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Geological Survey of Canada

I HAD often heard of great and mysterious floods that come down the Talsekwe River and swell the Taku to levels far above those caused by the melting of snow and ice or by heavy rains. I had even guessed at their source. This northwestern section of British Columbia, a part of the Coast Range, is a region of extensive ice fields and glaciers.[1] The bursting of a glacial dam, such as is known

FIG. 1—The Talsekwe Valley after the flood.

to occur in other parts of the world, would explain the type of flood that comes down the Talsekwe. In the summer of 1932 I had the opportunity of verifying my supposition.

The Talsekwe River normally emerges from one large and several smaller caves in the front of the Talsekwe Glacier. The glacier is more than fifteen miles long and about a mile and a half wide at its terminus. The river flows with a steep gradient over a gravel-floored valley more than one mile wide. For about eight miles below the glacier vegetation on the bottom of the valley is confined to a few islands and isolated strips along the valley wall. Even during normal times the water is spread out into many channels and is continually changing its course.

In August, 1932, my party made camp at a cabin eight miles up the river at the mouth of the largest tributary. From here we set out on a side trip. Fearing a flood, we had dragged our 24-foot river boat up a narrow creek to a point where it was protected from the main channel by about one hundred feet of heavily wooded ground. A few days later, looking down on the river from a high peak, we were startled to see that water covered about one-half of the flat instead of the usual

[1] F. A. Kerr: Ice Fields of Western Canada, *Canadian Geogr. Journ.*, Vol. 7, 1933, pp. 234–246. See also J. T. Mandy: Report on the Taku River Area, Atlin Mining Division, North-western Mineral Survey District, *British Columbia Dept. of Mines Bull. No. 1, 1930*, Victoria, 1930.

FIG. 2—Twenty-foot cubes of ice were carried more than 500 feet.

one-seventh. We made a flying return trip to the cabin. Water was pouring through the clumps of trees along the sides of the valley. Already the hundred feet of land protecting our boat had been all but swept away. Navigation was impossible. Water now covered practically the entire mile-wide valley flat. For six days the waters tore by, continually rising higher. Whence came such a volume of water, a mile wide, one to five feet deep, and flowing ten miles an hour for six days? After the sixth day recession began. For twenty-four hours the water fell steadily, at first little more than an inch an hour. We attempted to proceed by boat up river, but there was no navigable channel—just a mass of water running everywhere; so we walked where yesterday had been a rushing torrent four to six feet deep.

In two days we reached the hole from which the water had emerged. The glacier was cut back for more than 100 feet to where it was 50 or 60 feet thick, and the

FIG. 3—The great hole in the glacier from which the flood waters escaped.

frozen gravels were cut into for a depth of 20 feet or more. A vertical wall marked one side; the ice had caved in and the hole was obscured by a jumble of huge blocks of ice. Extending outward was a fan of other ice cakes. Some 20-foot cubes had been carried for more than 500 feet; great boulders lay all about; and channels 10 to 15 feet deep were cut in the outwash plain.

Two days up the crevassed surface of the glacier brought us to the source of the flood—an awful place, an inferno of ice. On two sides of a great hole sheer granite

FIG. 4—Thousands of blocks of ice left precariously perched by release of the ice-dammed lake.

walls rose to high, mist-wreathed peaks; on the third visible side was a section of the Talsekwe Glacier turned aside from the main valley. Its deeply crevassed mass merged with the jumble of enormous ice cakes filling the hole—thousands of them, of all shapes and forms, creaking, cracking, and groaning as they settled on one another.

We could see where the water level had stood, about 900 feet above the outlet at the end of the glacier. The hole, formed by retreat of the glacier that once occupied this tributary valley and blocking of its mouth by the Talsekwe Glacier, was fully 3 miles long, 1 mile wide, and as much as, if not more than, 500 feet deep at the lower end. Into the rising lake that forms behind the dam the glacier discharges great icebergs. When it reaches a certain level it probably overflows. Originally when the tributary valley was occupied by a glacier an under-ice passage carried water to the end of the main glacier. Now most of the time this is blocked, but once in a while, probably because of the breaking off of a berg, it opens up. Once started, the rush of water with its 900-foot head increases the size of the tunnel and there is no stoppage until most of the water has gone and some of the bergs floating on top are washed into the tunnel mouth, blocking it again. Generally every year, in the fall or winter, there is a flood, but some years the hole does not open or perhaps has not closed and no flood occurs.

LAND UTILIZATION SURVEY OF BRITAIN

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THE "Land Utilisation Survey of Britain,"[1] now nearing completion, has for its object the making of a cartographic record of the present use of every acre of land in England, Wales, and Scotland. Such a factual record as the Survey presents may be used both as a standard of comparison with the past and as a basis of planning for the future. An illustration is in order.

Value of the Survey

Soon after the Survey was initiated in 1930 an official of the Ministry of Agriculture drew the attention of the writer to the existence of a manuscript record of land utilization relating, in general, to the years 1840–1841. From this record, which had been made in connection with certain changes in taxation, it is possible to construct a land-utilization map of much of the country for a period nearly 100 years ago. A comparison of the two surveys has been carried out for a number of selected parishes in the region southwest of London.[2] While it would be unwise to generalize, the results are interesting. They show, at least, how unwise it is to draw too many conclusions from published statistics alone! Statistics show a steady decrease in the arable acreage of Britain, offset mainly by an increase in permanent grass. On the whole, the trend is the same in all parts of the country: clearly the major causes are economic. When one comes to study the detailed land-utilization maps, however, the importance of local geographical factors is evident. There is a marked stability of conditions on the poorest land, a stability also on the best land—the changes are on land that from the point of view of soil and other factors is, as arable land, marginal. It might be thought that in this modern economic world the geographical factors would have ceased to be of primary importance. On the contrary their influence is more clearly traceable than ever in the past. A vast field of investigation is open to comparative study of this nature. It should lead to the establishment of trends in different parts of the country with different sets of factors and should furnish a key to future utilization.

The direct uses of the survey have already been shown in a variety of ways. Several town and regional-planning authorities have taken the survey as a basis for their work, in order to proceed in such a way as to upset existing utilization as little as possible. A forestry research station is using existing distribution of wood lots as a clue to possible types of afforestation. A large city corporation has been able to demonstrate visually the importance of preserving certain tracts of land as public open spaces. One of the four main railway companies of Britain is displaying the published maps at all railway stations in each area to demonstrate the attractive nature of the country accessible by use of their round-trip tickets. A scheme for a great national park is able to show how roadways from populous areas to the park could be constructed without the purchase of large tracts of expensive improved land.

Looked at broadly, a survey of existing land use is an essential prelude to all large-scale planning. In America, where land is abundant, it might be argued that as soon as a tract becomes desirable as part of a town development scheme its value

[1] "Utilisation" is the spelling in the official title of the organization.

[2] L. D. Stamp and E. C. Willatts: Changes in the Utilisation of Land in the South-Western Part of the London Basin, 1840–1932 [abstract], *British Assn. for the Advancement of Sci., Rept. Ann. Meeting, Leicester, 1933 (103rd Year)*, London, 1933, pp. 500–501; E. C. Willatts: Changes in Land Utilization in the South-West of the London Basin, 1840–1932, *Geogr. Journ.*, Vol. 82, 1933, pp. 515–528.

to the realtor so far exceeds its value to the agriculturalist that its existing utilization can be ignored. This is not the case in Britain. Within a radius of 20 miles from the heart of London may be found the most intensively cultivated land in the whole country, some of the finest orchards, but also some of the poorest land, agriculturally speaking, in the south of England. It is true that, measured in terms of money, even the best agricultural land would have a greater actual value if used for "development" purposes, but its loss as agricultural land would be irreplaceable to a community that is already overdependent on oversea supplies and that has, at the same time, an abundance of poor land. Within the confines of Greater New York there is also an abundance of agriculturally poor land excellent for residential areas. Westchester County has given Greater New York an unrivaled series of parkways, which may well be a nation's pride. But such a system would be impossible near London because of the greater value of land agriculturally. The parkways have increased enormously the value, for residential development, of adjoining poor land. Parkways could also be constructed through the orchard or truck-farming country of New Jersey. But the cost of land would be greater, the loss of good agricultural land serious, the advantages to the community relatively small because of less attractive scenery; furthermore, the market value of adjoining land would show a smaller relative increase. What is, in one set of circumstances, a success might in other circumstances be failure—different circumstances are indicated by different land utilization.

Organization of the Survey

Work on the survey was started in October, 1930, and, as it was obviously desirable to have the survey as nearly as possible synchronous, completion within five years was the aim. Actually the survey of the greater part of England was completed in 1931–1932, of Wales and Scotland in 1932–1933. At the close of 1933 the quarter of the area remaining consisted of local gaps in otherwise completed areas or of tracts in remoter areas, such as the Highlands of Scotland, that are difficult to reach from closely settled centers and in which there is actually little to record.

The Survey may be said to have grown out of the Regional Survey Committee of the Geographical Association, of which the writer was secretary from 1927 to 1930.[3] An independent standing was made possible by the London School of Economics, which made a grant from the Laura Spelman Rockefeller Research Fund and provided a central office. Limitation of funds made it imperative that the survey should be a volunteer undertaking. The execution of the fieldwork as an educational exercise by university students, colleges, and schools presented itself as a possibility that would serve also the purpose of introducing the problems of the land into education. This aspect of the work has been considered fully elsewhere.[4] A simplified land-use survey made in Northamptonshire in 1926–1928 had already demonstrated what could be done through the schools of the country.[5] It is sufficient to state here that the extension of this method was remarkably successful: it is estimated that 10,000 schools and 250,000 pupils have assisted.

The work of the Survey was organized on a county basis. For the most part the Director of Education became the county organizer, and in most cases the funds of the county permitted the comparatively small expenditure required for a set of base maps for the area, sometimes for a duplicate set. Printed leaflets stating

[3] For a brief account of the history and organization of the Survey see L. D. Stamp: The Land Utilisation Survey of Britain, *Geography*, Vol. 16, 1931, pp. 44–51.

[4] L. D. Stamp: Land Utilisation Survey as a School and College Exercise, *Journ. of Geogr.*, Vol. 33, 1934, pp. 121–130.

[5] E. E. Field: The Land Utilization Map of Northampton, *Geography*, Vol. 15, 1929–1930, pp. 408–412. The results of this survey have been published in three special sheets on the scale of one inch to one mile by the Ordnance Survey.

exactly what had to be done were provided by the central office, and about 60,000 were used.

After completion the maps were collected at the county organizer's offices, examined for omissions or obvious errors, and dispatched to the central office, where each sheet was scrutinized and dated and then reproduced on a slightly reduced scale by the photostat process. The file of photostat negatives thus constitutes the permanent record of the survey, and copies can be made at any time, but in addition the original maps are being kept together as far as possible.

The Base Maps

Great Britain is exceptionally fortunate in possessing a magnificent series of base maps, on the scale of six inches to one mile, covering the whole country. These maps are usually issued in "quarter sheets" covering an area of six square miles. The maps show, among other features, all field boundaries and all buildings. Woodland, certain rough land, orchards, and marshes are the main types of utilization indicated by symbols. Normally over a large part of the country these maps are revised every 20 years, over the remainder every 40 years, so that the average age of sheets from the two sections should be 10 and 20 years respectively. Actually the revision has fallen considerably behind schedule, owing to the war and subsequent economies, so that the average age of sheets tends to be much greater. The fieldwork thus consisted, first, of checking the published six-inch maps and making any additions necessary and, second, of identifying each field or lot and recording its present utilization. In some of the remoter areas, particularly of Scotland, where there is little to record, some work was carried out on the one-inch scale.

By comparison with American conditions it will be seen that the existence of the six-inch base maps is an immense advantage. But this initial advantage is offset in two ways. In many areas the fields are ridiculously small, even averaging only about one acre. This is the case, for example, in Cornwall, where the work is further complicated by the fact that each field is bounded by a high wall—the stones collected from poor, rocky soil. Some surveyors have recorded that to visit each field conscientiously meant covering less than a square mile in a long day's work. There is nothing in Britain remotely resembling the regular rectangular layout characteristic of the Middle West of the United States. The Land Economic Survey of Michigan has shown how accurate can be work carried out there without base maps but on sheets marked with a rectangular grid.

Scheme of Classification

In drawing up the scheme of classification used in the Survey advice was sought from individuals and bodies, both official and nonofficial, representing a wide variety of landowners, land users, and potential land users. The scheme of land-use classification embraces six major categories. These are distinguished on the field maps by letters and, if desired, by color in addition, thus:

Category	Symbol	Color
1. Forest and Woodland	F	Dark green
2. Meadow and Permanent Pasture	M	Light green
3. Arable or Tilled Land	A	Brown
4. Heathland, Moorland, Commons, and Rough Pasture	H	Yellow
5. Gardens, Allotments, Parks, Orchards	G	Purple
6. Land Agriculturally Unproductive (buildings, yards, mines, etc.)	W	Red

The first category is subdivided into high forest (Fa), coppice (Fb), scrub (Fc), cut-over areas (Fd), young plantations (Fa plant), and wood lots for amenity purposes (symbol underlined); and in all of these distinction is made between coniferous, hardwood, and mixed type, and the names of dominant trees are inserted where possible.

Fallow and rotation pasture are included in the arable category. The distinction between rotation pasture and permanent pasture presents perhaps the greatest difficulty for the untrained observer: the general tendency will be to exaggerate the acreage of the latter. A special difficulty arises in certain parts of the country, particularly in the west of the Lowlands of Scotland, where "long lays" are practiced—land is left under grass for from ten to fifteen years and then plowed for two. Here special instructions were issued, and it was decided to record the present position, i.e. at the date of the survey, of grass and arable land. Again, the distinction between permanent pasture that has been somewhat neglected or undergrazed and rough pasture is not always easy to make. In cases of doubt, enclosed pastures, unless definitely abandoned or seriously neglected, were recorded as M; unenclosed rough pastures, though somewhat improved by grazing, as H. The difficulty is most serious in limestone country, where the natural vegetation is a grass turf. It is frequently impossible to draw a line between Fc (scrub) and H with scattered bushes or trees, and it is clear that this difficulty is marked in America.

An interesting correlation is possible between the results obtained by the Survey and the official statistics of the Ministry of Agriculture. Every year each farmer in Britain is compelled by law to make a return as of June 4 of livestock, acreage under crops (each specified), and acreage under other types of land use (corresponding with the classes used by the Survey). The returns are strictly confidential, but the figures are added together and published as the official statistics for counties and for the whole country. Provided there are several farms in one parish (the British equivalent of township), the figures for parishes, though not published, can be consulted. It so happens, however, that the boundaries of each parish—usually very irregular—include land of very varied types. This is, indeed, a natural result of the history of settlement—on the best land first, each settlement gradually taking in a tract of poorer land. Thus the results obtained by the Land Utilisation Survey supplement but do not duplicate the official figures. It should be noted also that the farm land covered by the official statistics represents only about 80 per cent of England and Wales and a smaller proportion of Scotland.

The Published Maps

The results of the survey are being made available to the public in the form of 1-inch-to-the-mile maps, printed in colors corresponding to the scheme for the field sheets. The sheets correspond in number and name to those of the fourth (popular) edition of the British Ordnance Survey, the land-use colors being overprinted on the contoured outline maps. Each sheet covers normally an area of 27 miles from east to west and 18 miles from north to south, or the equivalent of 81 quarter sheets of the 6-inch map. By experimenting with several mechanical methods of reduction it was found most satisfactory to carry out the work by hand, building up gradually a "colored model" on the "black outline" of the 1-inch sheet. Although every opportunity is taken to check the field sheets by traverses, it is during the work of reduction that checking and editing become essential. A number of discrepancies in the field sheets are due to differences in interpretation, and it is possible to remove some of these. But as the map is built up doubtful areas are left blank, to be completed later after a visit to each disputed tract. The secretary of the Survey, Mr. E. C. Willatts, has carried out most of the editing and much of the checking; the staffs and postgraduate students of the university departments of geography have rendered invaluable service in this direction.

The one-inch maps are being color-printed by the Ordnance Survey, the publishers of Britain's official maps. But the Land Utilisation Survey is defraying the cost of production, and the continuance of publication depends on public sales. The maps are obtainable from the Land Utilisation Survey's offices at 18 Houghton Street, London, W. C. 2, at a cost of 4 shillings each (paper folded, post free, or flat, postage extra) or, for field use, mounted on linen and folded in decorated covers, at 5 shillings. A first series of 20 sheets has been selected for publication in such a way as to illustrate the principal types of country found in Britain, and it is hoped that this series will prove especially attractive to geographers in all parts of the world.

The series is:

Scotland: *†South Shetland (poor crofting country); Aberdeen (moorland, forest, and arable, low rainfall); Mull (west, heavy rainfall); *Firth of Forth (Edinburgh and eastern part of Midland Valley); Ayr (wet, cattle country, west of Midland Valley).

England and Wales: *Lake District (wet, mountainous, tourist country); *Durham (moorland to the sea across coalfield); *†Liverpool (setting of a great port); *Birmingham (inland industrial center); Fenland (fertile drained marshland); *†Cromer (rich glacial arable land on dry east); *†Norwich (urban center of farming land); *Ipswich (small port and its setting); *Luton (cattle country of Midlands, passing into arable); *Windsor (southwest of London); Marlborough (open chalk downs and associated valleys); Northern Wales (hill farms); Cardiff (South Wales coalfield); Land's End (extreme southwest); *†Isle of Wight (mixed farming and residential, south of England).

* Published before August, 1934. † Descriptive memoirs in course of preparation. A smaller series of ten maps is also available. It includes the sheets marked above with an asterisk, excluding Birmingham and Norwich, and is accompanied with an explanatory booklet.

GEOGRAPHICAL RECORD

NORTH AMERICA

Completion of the Topographic Map of the Alluvial Valley of the Mississippi. The recent publication of a block of topographic sheets covering the alluvial valley of the Mississippi from the mouth of the Ohio to the Gulf of Mexico is an achievement of more than routine interest. The sheets, although conforming in scale (1 : 62,500), limits, and general style to the standard topographic map of the United States being produced by the United States Geological Survey, were published by the Mississippi River Commission on the basis of surveys by the Corps of Engineers, U. S. Army. The block, as outlined on the Commission's official index map, comprises 209 sheets in all. This includes, however, 32 sheets recently prepared by the Geological Survey in connection with the present undertaking, of which all but two are for the time being available only in the form of provisional impressions on the scale of 1 : 48,000. Of the area within the block thus outlined there had heretofore been no standard topographic maps with the exception of a few scattered sheets. Outside the block, in the delta region south of 30° 15′ N. and east of 91° W., there have existed since the early 1890's 34 sheets in 1 : 62,500 by the Geological Survey, of 8 of which the Survey has recently published new editions without contours, each in four sections on the scale of 1 : 31,680, based on air photographs taken in 1932. If these—partially, to be sure, somewhat outdated—sheets are taken into consideration, it will appear that a detailed representation is now available of the whole alluvial belt from Cape Girardeau, Mo., to the foot of the Passes.

As to content, the 177 sheets prepared by the Mississippi River Commission are considerably fuller in the portrayal of man-made features than the customary topographic sheets of the Geological Survey. This is well illustrated on some of the few sheets of identical areas made by the two agencies, such as the Reelfoot Lake, Memphis, and Baton Rouge sheets, which also provide interesting evidence of changes in the physical and cultural landscape in the ten to twenty-five years elapsed between the two surveys. Physical features are represented in the same manner (relief in brown contours, interval 5 feet; woods in green overprint on *all* sheets). Culture, however, includes the following items not usually shown on Geological Survey sheets: levees; dikes; revetments; bench marks differentiated according to grade, local designation, and surveying agency by which established; boundaries of irregular land parcels where replacing the section system in the riverine belt in Louisiana. State and county boundaries, especially thalweg boundaries, are stated to be shown "according to best available information and [to be] subject to change except where established by court decision." The engraving and printing (by the Army Engineer Reproduction Plant in Washington) are good but on the whole are not so delicate as the work done by the Geological Survey.

Not only will the new series cater to the manifold purposes for which such a map is used, but for the first time it will provide the physiographer with an adequate tool for the study of this, the world's second largest river. Although maps of the Mississippi on the same scale and even on a larger scale have long been available in the two series of charts in 1 : 20,000 and 1 : 63,300 published by the Commission, the topography on them is limited to the immediate vicinity of the river. In the present series, however, the entire width of the flood plain is displayed, thus providing a suitable picture for the study, in its proper setting, of the pattern of meanders, active and abandoned, and flood-plain scrolls (see H. S. Sharp, *Geogr. Rev.*, Vol. 16, 1926, pp. 490–491, and Douglas Johnson, *ibid.*, Vol. 19, 1929, Fig. 1 on p. 136, and text) that the map, reproducing the crescentic forest strips and dry channels of the air photographs on which it is based, so characteristically portrays.

The map was prepared mainly to provide a basis for planning the flood-control

measures that were under consideration after the disastrous floods of 1927 (see especially "Topographic Mapping of Mississippi Valley: Hearings before the Committee on Flood Control, House of Representatives, Seventieth Congress, First Session, on H. R. 11142," Washington, 1928; "Flood Control in the Mississippi Valley: Report Submitted by Hon. Frank R. Reid . . . from the Committee on Flood Control," *70th Congr., 1st Sess., House Report No. 1072*, Washington, 1928; and Chapters 9 and 10 in the monograph by A. DeW. Frank reviewed in *Geogr. Rev.*, Vol. 21, 1931, pp. 697–698). The roughly 45,000 square miles represented by the 177 sheets published by the Mississippi River Commission were surveyed by the Corps of Engineers in a little more than three years (1929–1932), and the resulting maps were engraved and printed with promptness (1930–1933) on the progressive completion of the surveys. Revised second and third editions of the different sheets have since been appearing rapidly.

These figures are of interest in connection with the need for topographic maps that the present national land-planning undertakings have made acutely evident. The area surveyed and the number of sheets published apparently exceed considerably the Geological Survey's annual average in the corresponding categories during the six fiscal years ending in 1932–1933 (11,000 square miles for publication in 1 : 62,500; probably about 50 newly engraved sheets on this scale, although specific figures by scales are not available: see the reports of the Topographic Branch and the Division of Engraving and Printing in the Director's annual reports for those years). With only 45 per cent of the continental United States topographically mapped and of this only about three-fifths adequately, and with the Temple Act of 1925 (*Geogr. Rev.*, Vol. 17, 1927, p. 324) ineffective, because not mandatory as to appropriations, in achieving its purpose of bringing about the completion of the mapping of the country by 1945, any example pointing to an adequate and rapid solution of the problem is welcome. That the rate of progress predicated by the Temple Act (at that time 59 per cent of the country, or roughly 1,750,000 square miles, to be surveyed in twenty years) is not unreasonable will appear when it is remembered that the Survey of India surveyed 60 per cent of the total area of that country including Ceylon, or about 1,100,000 square miles, and published the resulting contoured topographic map on the scale of 1 : 63,360, with relief in almost as great detail as on the American map and with culture in greater detail, in the space of 28 years, a period that would, according to the opinion of the Surveyor-General, have more than sufficed for the completion of the whole undertaking but for the disruption caused by the World War (see *Survey of India General Rept.*, 1933, Calcutta, 1934, Preface, p. 2).

The Forest Limit in Alaska. The Arctic timber line (coniferous forest) is one of the chief vegetational boundaries of the earth, of "fundamental importance" from "every point of view" (R. F. Griggs: The Problem of Arctic Vegetation, *Journ. Washington Acad. of Sci.*, Vol. 24, 1934, pp. 153–175). The forest line is roughly coincident with the July isotherm of 10° C., but the departures are important. On the Alaskan peninsula the forest, which ends at Kodiak, is 250 miles south of the isotherm; east of the Mackenzie it is nearly 150 miles in advance; west of Hudson Bay the forest falls behind to gain in northern Labrador; in western Eurasia again the forest lags behind the temperature line to pass far in advance in the extreme east. Robert F. Griggs suggests that the irregularities of the forest in relation to the climatic line point to lack of adjustment of the present vegetation and offer a profitable field for research in climatic change. He himself while engaged in his well known volcanic studies at Katmai has investigated conditions in southwestern Alaska (The Edge of the Forest in Alaska and the Reasons for Its Position, *Ecology*, Vol. 15, 1934, pp. 80–96). Advance of the spruce forest at Kodiak is indicated by the following observations: all the trees near the edge of the forest are young; many of the old trees now

in dense stands are of the "open ground" type; the rate of growth at the edge of the forest compares favorably with that in southeastern Alaska; early Russian explorers reported treeless areas that are now forested; the peat bogs yield only a few scattering grains of spruce pollen (P. W. Bowman: Pollen Analysis of Kodiak Bogs, *Ecology*, Vol. 15, 1934, pp. 97–100). The conclusion is that the advance of the forest is "a long-term secular migration into new territory rather than a phase of a cyclic oscillation back and forth."

Professor Griggs notes that investigations made by Robert Marshall around Bettles in northern Alaska were attended by similar results.

Beach-Erosion Studies in the United States. The increasing use of beaches for recreational purposes and the resulting increase in value of lands fronting the sea have brought to the fore the problems of beach erosion and shore protection. The protective works that have been built have not always been successful, for the factors involved in beach erosion are exceedingly complex, and the studies made heretofore have not been sufficiently comprehensive and systematic properly to evaluate these factors. In the discussion regarding these matters at the meetings of the American Shore and Beach Preservation Association, which was called into being by the Committee on Shoreline Investigations of the National Research Council (cf. D. W. Johnson: The Problem of Coast Protection, *Geogr. Rev.*, Vol. 17, 1927, pp. 135–137), it became evident that what was needed was a properly constituted central agency for the study of the whole question.

Largely as a result of the efforts of this association, the River and Harbor Act of July 3, 1930, authorized the Secretary of War "to cause investigations and studies to be made in cooperation with the appropriate agencies of various States . . . with a view to devising effective means of preventing erosion of the shores of coastal and lake waters by waves and currents," and it further authorized the organization of a board now known as the Beach Erosion Board. Under date of April 15, 1933, this body has issued in mimeograph form a report of some 130 pages entitled "Interim Report of Beach Erosion Board, Office of the Chief of Engineers, U. S. Army."

The fundamental nature of the investigations summarized in this report is evident from their mere enumeration. They include studies of sand movement along the shore, of longshore currents and their causes, of characteristics of wave action and force of waves, and of effectiveness of shore-protection structures. In connection with each of these studies various experiments were made to derive the basic data, and the results are summarized. Of particular interest is the table listing the data on the accretion and erosion of beaches at a number of places along the coast of New Jersey over a period of some 80 years, which shows that at some places there has been erosion and at others accretion. Experiments carried out to determine whether the ocean bottom some distance offshore is an important source of beach-building material led to the conclusion that as far as beach-protection structures are concerned the sea bottom offshore cannot be counted upon as a source of beach-building material. It was found that the bulk of the sand movement occurred within 350 feet of the low-water line. One valuable feature of the report is a glossary of the technical terms used, of particular service since many of the terms have been used in a loose sense by various writers.

H. A. MARMER

The Evolution of Tidal Inlets. The rôle played by the tidal inlet in the development of a young shore line of emergence is a combination of enemy and friend not only to the maintenance of navigable waters between ocean and protected lagoon but to the permanence of the beach itself. An understanding of the stability of a tidal inlet and its ability to remain open is of immense practical value. An instance is given by John B. Lucke in "A Study of Barnegat Inlet, New Jersey," a typical inlet on the Atlantic seaboard (*Shore and Beach*, Vol. 2, 1934, pp. 43–94).

The results of this survey emphasize the necessity of considering as an entity erosional and depositional factors working together to control the inlet history. Mean sea level has been shown to be distinctly higher in the lagoon. Because of the greater variation between the low-tide levels of ocean and lagoon, the ebb current should have the greater velocity. This has been proved to be so by careful measurements with a current meter. Whereas the flood tidal currents tend to deposit their load on the shoals, the ebb currents erode the channels and thereby affect the migration of the inlet. Sedimentary studies indicate that the lagoon delta is largely a product of deposition of medium to fine beach sand in quiet water by the incoming tide. Increase of silt and organic material landward is partly accounted for by entering streams, but the chief source of lagoon fill lies on the ocean side. Although the assembled sedimentary facts suggest a recent moderate southward trend of the inlet, it is pointed out that "no one of the features [of sedimentation] mentioned is alone conclusive evidence either for, or against, inlet movement."

Perhaps the most interesting outcome of the study is a carefully deduced theory of lagoon evolution on a young coast line of emergence. This forms a new approach to the interpretation of recent shore-line evolution by use of charts. The pattern of the sediments developed in the lagoon should have a direct relation to the number and stability of the tidal inlets. Four theoretical sets of conditions are assumed and their consequences deduced: (1) Inlets open simultaneously and remain stationary. (2) Inlets open successively and remain stationary. (3) Inlets open simultaneously and migrate rapidly. (4) Inlets open successively and migrate rapidly. The similarity between examples from charts and the deduced results is striking. The theory stands as a useful working hypothesis in interpreting young coast lines of emergence and deserves a thorough test as further detailed coastal studies with inlet problems are carried on.

C. B. HITCHCOCK

The Chronicle of the Prairie. To the casual traveler across the prairie it may appear to be little more than a tiresome expanse of grasses. But let him stop and scrutinize. "The beauty and the quiet calm of the grassland should not obscure the fact that the prairie is a field of battle centuries old in which the conflicting species, never wholly victorious nor never entirely vanquished, each year renew the struggle. It is the bitter struggle for mere existence, for light, water, nutrients, etc., eagerly sought by numerous competitors. Each species would increase its holdings; but parent plants must compete with their own offspring; as a result the population becomes enormously overcrowded for the best development of the individual. Consequently all are reduced in size and underdeveloped compared to the stature they could attain. They often fruit sparingly rather than abundantly, and take years to accomplish what, unhindered by their fellows, might be accomplished in a single season." Such is the view presented by J. E. Weaver and T. J. Fitzpatrick in "The Prairie" (*Ecological Monographs*, Vol. 4, 1934, pp. 109–295).

In this, the third of a series of studies on the prairie—the first on the environment, the second on the ecology and relative importance of the dominant grasses—the authors seek to round out a permanent record of this unique but rapidly "Vanishing American" entity and to secure a better understanding of its features and problems, including its intelligent conservation. Using quadrat and transect and selecting 135 tracts ranging from 20 to 360 acres in size, they subjected the nature, development, continuity, and intimate structure of this great grassland formation to painstaking examination. Beginning with the awakening of the grasses and forbs in the spring, the study was carried into the season of winter dormancy over a period of three years (1929–1931) with a fourth summer as check. This provided a record of each season's aspect—five in all: prevernal, vernal, estival, autumnal, and hiemal—a dynamic sequence of immensely greater value than any momentary picture in deciphering the

economic potentialities or the most provident management practices. Furthermore, the multitude of species proved happily classifiable into some half a dozen types or consociations adapted to regional studies.

Aside from the record of fact that is highly engaging in itself, the geographer will find many of the ecological conclusions of interest. In spite of the incredible population pressure, before which the corresponding human agglomerations seem sparsely occupied, each species executes its cycle with a surprising perfection. The trick is accomplished "by sharing the soil at different levels, by obtaining light at different heights, by making maximum demands for the factors at different seasons of the year, by fitting into the niches unoccupied by other species, and by actually profiting by the incidental benefits afforded by the community of which they are a part. The legumes add nitrogen to the soil; the taller plants protect the lower ones from the heating and drying effects of full insolation; the mat formers and others prostrate on the soil further reduce water loss by covering its surface. They live in an atmosphere much better supplied with moisture than the windswept plants above. Light is absorbed at many levels, the more or less vertical leaves of the dominant grasses permitting some light to filter between them as the sun swings across the heavens."

The facts and relationships of the prairie are also highly significant in their bearing upon certain pedological considerations and soil economics. Soil students in late years have been coming to regard the natural vegetation as the final arbiter in a soil's character. The prairie grassland is accordingly the critical artificer of our rich prairy-erths. Does its destruction in the face of plow and grazing herald the ultimate vanishment of our unique prairie soils also? Or can we infuse the virtues of the prairie consociations into a crop and land-utilization system that will preserve their unparalleled characteristics for us? The prairies are a very rich pasture for research!

LOUIS A. WOLFANGER

Geomorphic Processes at High Altitudes. Geomorphic processes in areas of intense frost action have long been discussed in generalized terms. Consideration of the details and separation of individual processes for discussion are now being attempted by many workers. An example is Charles H. Behre's study of "Talus Behavior above Timber in the Rocky Mountains" (*Journ. of Geol.*, Vol. 41, 1933, pp. 622–635).

Talus is, according to the strictest definition, a heap of débris at the foot of a cliff. If blocks fall from a cliff to form such a heap, the larger will roll farther than the smaller and the heap will be graded upward from coarse to fine. Behre observed talus grading in the opposite direction, i.e. the coarser fragments above. He holds that this differentiation in size is due to comminution of the fragments by weathering after they have taken their place at the top of the talus. The lower parts of the talus are regarded as the older. It must be supposed that the process of talus formation is near completion or that there is a progressive movement of the talus from the top of the slope to the bottom. It thus appears that most of the talus described by Behre is a creeping mantle of rock fragments overlying a sloping bed rock. The mantle has observed inclinations of 26° to 35° and is a measure of the inclination of a weathering slope on the underlying rock. One wonders what difference there may be between such a mantle of rock fragments and a layer of frost-heaved blocks or warp. The "downslope" pattern of the talus resembles the stripes or "Streifenböden," the "contour" pattern the rock garlands or "Steingirlanden," described from many Alpine and Arctic areas (see Wilhelm Salomon: Arktische Bodenformen in den Alpen, *Sitzungsber. Heidelberger Akad. der Wiss., Math.-naturw. Klasse*, 1929, No. 5). Solifluction and altiplanation occur not only on steep but on gentle slopes. Behre's Figures 3 and 4 are taken just at the upper edges of steep slopes where the inclination cannot be more than 10°. Thus it seems that this type of

"talus" is essentially a warp, although the phenomena of frost heaving are not so intense as to produce the more pronounced features. According to Salomon, the phenomena of the high mountain areas differ from those of the Arctic in that the forms of "Strukturböden" are less marked. He holds that solifluction—the movement of débris over a permanently frozen subsoil—may be absent except in favored places.

The talus cones described in the latter part of Behre's paper lie at the foot of cliffs and are true talus heaps. Here running water rearranges the material, and gullies with torrent levees (I. C. Russell's term) are characteristic.

W. S. Cooper's interesting studies of the vegetation of the Mt. Robson area (*Plant World*, Vol. 19, 1916, pp. 211–238) deal with talus cones located largely below timber line. He gives us a vivid picture of the contest between the frost and the rolling blocks from above. Definite lanes or pathways through the forest are maintained where the falls of blocks are numerous. These are, however, true talus heaps, not a frost-heaved veneer. Here also, as described by Behre in the latter part of his paper, there are ridges of blocks at the foot of the larger talus heaps. These are the nivation ridges of Behre. Now the word "nivation" is the name of a process of excavation around snowbanks described by Matthes. The use of the same word for these ramparts of blocks is likely to prove misleading, and the reviewer suggests that "protalus rampart" would be appropriate for the features. The ramparts described by Cooper are covered by a climax forest and date back to a time when larger snowbanks overlay the talus and furnished a sliding surface for blocks from above. The features described by Behre belong in the present cycle.

This study by Behre and the somewhat more generalized study by R. J. Russell already reviewed (*Geogr. Rev.*, Vol. 24, 1934, pp. 488–489) give an American viewpoint on the land forms of high mountains much needed in view of the interest already shown in Europe.

KIRK BRYAN

Benches, Terraces, and Glacial Features of the Northern Great Plains. In "Physiography and Glacial Geology of Eastern Montana and Adjacent Areas" (*U. S. Geol. Survey Professional Paper 174*, 1932) W. C. Alden presents the results of many seasons' work on the part of himself and colleagues in the field. His report is illustrated with illuminating photographs, maps, and sketches, and a separate map on the scale of 1 : 500,000. The invasion of the area at least twice by the great Keewatin Glacier of the Ice Age left a mantle of drift and produced important drainage modifications. The Missouri left its ancient valley—that of the present Milk River—to cut a new gorge and a remarkable series of waterfalls around and below the site of Great Falls. At the same time there were notable extensions of glaciers from the mountains on the piedmont, with the development of remarkable features of glacial erosion and deposition. An attempt has been made to correlate the stages of development with those of features of the Mississippi Valley and the Great Lakes region.

On the high, gravel-capped bench lands near the mountains of Glacier National Park are very old deposits of drift, laid down by the Rocky Mountain glaciers at an earlier time, during either the Nebraskan or Kansan glaciation. These high bench-land gravels are not, however, so old as the gravels capping the Cypress Hills in southern Alberta and Saskatchewan. Since the time when the Cypress gravels were laid down (Oligocene or Miocene) the South Saskatchewan River and other streams have cut down 1000 to 2000 feet in the longitude of the Cypress Hills. It was not until the middle or late Tertiary (Miocene or Pliocene) that the streams halted their downcutting and laid down what are now the highest of the bench gravels of which there are remnants near the mountains. These benches were developed by the coalescence of great alluvial fans into a piedmont terrace. With these is probably

to be correlated the Flaxville gravel of northeastern Montana. Uplift of the region was renewed and the first of the Rocky Mountain glaciers developed and extended on the piedmont terrace. At the same time the streams farther east began to cut into the plains and to erode their inner gorges. While it is probable that a great ice sheet centering west of Hudson Bay extended into the Dakotas at the same time as the mountain glaciers first developed, it is not known that the ice at that time reached the present position of the Missouri River either in northeastern Montana or in northwestern North Dakota. The Keewatin ice appears to have reached and crossed the Missouri and to have blocked the lower Yellowstone at a much later time (Illinoian or Iowan) after their gorges had been cut down to their present depths. Later deposits represent the Wisconsin stage. There is a succession of remarkable gravel-terrace remnants, especially well preserved along the Yellowstone River, which range in height from 100 feet or less to 1000 feet or more above the present streams.

Studies of Colonial Connecticut. Connecticut is now famed for its splendid highway system. In the colonial period, however, its roads had a bad reputation even in America, where there were few good roads anywhere. Many rivers, an irregular coast line bordered with marshes, and rugged uplands densely clothed in forest rendered the construction and maintenance of roads difficult and costly. The Connecticut Yankees, moreover, were "so strongly individualistic . . . that neither persons nor towns would coöperate in any enterprise which required the subordination of their own particular rights to the general good of the community unless they could see some immediate benefit to themselves." Within each town the necessity of attending church stimulated the construction of roads. "For not only did a man's escape from eternal damnation depend upon his going . . . regularly [to meeting], but he was further liable to a fine by the court, if he were not present." The comfort of the relatively few travelers who came from afar was a matter of indifference to the towns, on which was laid the duty of maintaining the through roads—or "King's Highways," so called—and the condition of these highways was lamentable. The larger streams all had to be crossed by fords or ferries, and what bridges there were were likely to be flimsy in the extreme. No bridge built in colonial times has survived. Persons coming from Boston "frequently went by land as far as Newport or New London, where they took ship to Oyster Bay and thence [proceeded] through Long Island to New York, or they went all the way by water." A through stage service between Boston, Providence, and New York was not inaugurated until after the Revolution.

These details are taken from a pamphlet by Isabel S. Mitchell, "Roads and Road-Making in Colonial Connecticut," published by the Yale University Press, 1933, for the Committee on Historical Publications of the Tercentenary Commission of the State of Connecticut. Several other pamphlets in the same series contain material of geographical interest. J. F. Kelly, for example, in discussing the "Early Domestic Architecture of Connecticut" shows that the earliest true houses were frame dwellings built of oak. The majority of the early settlers "were natives of regions . . . [in England] in which oak timber was plentiful, and its use a fixed tradition. . . . It was but natural, therefore, that these first settlers, finding an abundance of virgin oak in the Connecticut forests, should have at once brought into play their native building traditions." One is tempted to wonder whether, had they come from a land of stone houses, they would have built stone dwellings, using the rocks with which the Connecticut countryside is strewn. Kelly points out that the colonial dwellings were painted red, yellow, or blue—not white, as is usually supposed.

If Connecticut's widest claims to territory had been maintained, her present boundaries would extend from Narragansett Bay to the Pacific Ocean and would include eastern Long Island and a large slice of Massachusetts. Had all her claims

been decided against her, she would now be restricted to an area about the size of Rhode Island lying wholly to the east of the Connecticut River. These and other facts about the evolution of the boundaries, including an explanation of the curious "bite" that Massachusetts appears to have taken out of the northern edge of Connecticut, are presented in the pamphlet by R. M. Hooker.

The settlement of Connecticut, as of all the colonies, was accompanied by ceaseless disputes over land. "While Connecticut's life flowed smoothly on the surface, it was in a constant state of agitation beneath, in the effort to fit together into a harmonious whole . . . thousands of pieces of landed territory and to satisfy, justly and equably, the claims and demands of rival and warring parties." Some idea of these controversies, especially those between towns, may be gained from two pamphlets by Dorothy Deming, "The Settlement of the Connecticut Towns" and "Settlement of Litchfield County," and from L. W. Labaree's study "Milford, Connecticut: The Early Development of a Town as Shown in Its Land Records."

The Recreation Industry. A recent survey of the vacation industry in New England finds that "it now produces an income second only to the textile industry." "Many towns in New England are practically dependent for their very existence upon the use of their land for recreational purposes. With land becoming submarginal for agricultural or industrial uses, these hamlets would have declined to a state of stagnation if the acreage could not have been turned to recreation. Economically and socially the resulting change is an important force in the life of New England today." Two typical towns have been studied—Bristol and Sandwich, New Hampshire. Conditions in Bristol show that despite a loss of 50 per cent of its industrial population and a nearly equal decline in agriculture the population has increased and the standard of living risen—facts attributed to the recreational industry. A survey of Sandwich produced data and conclusions very similar to those for Bristol. An analysis of the ownership of recreational property in New England showed that the greater part of Massachusetts' recreational land is owned by Massachusetts people; that the residents of Connecticut possess slightly more such property than nonresidents; and that almost one-half of New Hampshire's, more than one-half of Maine's, and most of Vermont's recreational property is owned by nonresidents (L. W. Chidester: The Importance of Recreation as a Land Use in New England, *Journ. of Land & Public Utility Economics*, Vol. 10, 1934, pp. 202–209).

One-eighth of the total land area of Connecticut is devoted to recreational uses. Of this, about 63 per cent is used for summer residences, 17 per cent for state parks and forests, and 7 per cent for parks and athletic fields. The land in recreational uses in 1930 was more than 11 per cent greater than the crop area of the state in 1929, and even after subtracting the state forest area the recreational land amounted to 95 per cent of the total acreage from which crops were harvested in 1929. In 1930 summer residences were distributed in 130 of the 169 towns of Connecticut, with a strong tendency for them to cluster in the New York area, the coastal region, and the Berkshire area (N. L. Whetten and V. A. Rapport: The Recreational Uses of Land in Connecticut, *Storrs Agric. Exper. Sta. Bull. 194*, 1934). In Massachusetts it is stated that indications are that much of the land withdrawn from agriculture is being devoted to recreational and forestry uses. An analysis shows that Essex County is by far the most important on the basis of valuation in the recreational development of its land resources, and, of the inland sections, Berkshire County occupies the most important place. Nonresident ownership is higher in towns with a higher average elevation and also in towns with a small amount of level land. In contrast with the intensive development of recreational property in the coastal region and sections of Berkshire County many inland communities make too little use of their attractive surroundings (David Rozman: Recreational and Forestry Uses of Land in Massachusetts, *Massachusetts Agric. Exper. Sta. Bull. No. 294*, 1933).

From Wisconsin comes the statement that "'organized hospitality' or the entertainment of tourists as a business has grown by leaps and bounds, and has become one of the major industries of Wisconsin. It is claimed that it is the fourth largest in the state, being exceeded only by motor vehicle manufacturing, dairying, and the industries which include machine shops, foundries and structural iron and steel plants." That the recreational use of the land as a possible solution of the "idle land" problem is limited is the conclusion of the author, for practically only the land fronting on rivers and lakes is desired and, in a few places, land not bordering on bodies of water but with value for hunting and recreational clubs. It is important, however, from the viewpoint of taxation. The areas with extensive recreational use of the land not only are a large part of the tax base but are comparatively free from tax delinquency (G. S. Wehrwein and K. H. Parsons: Recreation as a Land Use, *Univ. of Wisconsin Agric. Exper. Sta. Bull. 422*, 1932).

In Michigan the importance of recreational lands in the cut-over lands of the northern part of the lower peninsula from the viewpoint of taxes is shown by the fact that in some townships recreational properties pay 85 per cent of the total tax payment for the township (W. O. Hedrick: Recreational Use of Northern Michigan Cut-over Lands, *Michigan State College Agric. Exper. Sta. Special Bull. No. 247*, 1934; for a study of the situation in Roscommon County in this area see E. C. Prophet: Significance of Recreational Development in Roscommon County, Michigan, *Papers Michigan Acad. of Sci., Arts and Letters*, Vol. 16, 1931, pp. 313–327, Ann Arbor, 1932).

Place-Name Study in the United States. The study of place names is a phase of geography that has been largely neglected in the United States. All the more welcome are the contributions noted here. J. T. Link has investigated place names in Nebraska. About 10,000 names were catalogued and explained, all of which are now on file in the offices of the state Geological Survey. His report "The Origin of the Place Names of Nebraska" (*Nebraska Geol. Survey, Univ. of Nebraska, Bull. 7 (Ser. 2)*, 1933) gives full but concise discussions of about 5000 terms. The first two chapters deal with the meaning and the history of toponomy and the technique followed in the investigation. Much attention is then given to the names most commonly used, such as those of the state, counties, larger cities and towns, cultural features, and drainage features, and aboriginal names.

Of especial interest to geographers outside Nebraska are the two closing chapters, "The Significance of Place Names" and "Toponomic Principles Involved in the Place Nomenclature of Nebraska." In these chapters Dr. Link presents strong arguments for the geographic values to be derived from a scientific study of place names. NELS A. BENGTSON

The fact of the diverse origins of the people of Oklahoma is demonstrated by Charles N. Gould in his "Oklahoma Place Names" (University of Oklahoma Press, 1933). He finds outcroppings of names indicating the historical periods of exploration —French, Spanish, and English. He sees in Oklahoma the meeting ground of settlers from north and south. Occasional foreign settlements are indicated by such place names as Kremlin, Prague, Berlin, and Hamburg.

Place names reminiscent of the cattle days are numerous, used particularly in the designation of creeks. Other names are directly attributable to the agricultural diversity of the state; thus Cotton County, Wheatland, and Cornville. Names derived from the mineral products of the locality are widely distributed: Asphaltum, Gilsonite, Tar Creek, Oil City, Oilton, Gaswell, Gas City, Bromide, Cement, Marble City, Limestone, Flint, Granite, Quartz, Salton, and Zincville.

Much of the material in the book is of purely local historical interest. Dr. Gould shows how Redoubt became Readout and Bois d'Arc became Bodock and how the

first letters of Oklahoma, Arapaho, and Cheyenne served to inspire Okarche, the name of one of the first settlements in the Cheyenne-Arapaho Indian Reservation. He shows also how the last letters of Cherokee and Cheyenne produced Okeene and how a typographical error produced the Irish O'Keene. In like manner Lockridge derives its name from being on a ridge near the junction of Logan, Oklahoma, Canadian, and Kingfisher counties. Yewed comes from the reversal of Dewey and Enid from the reversal of "dine"!

Because of the unusual history of the area forming the state of Oklahoma Indian names are particularly numerous. The word "Oklahoma" itself is of Choctaw origin and means "red people." C. W. THORNTHWAITE

"Introduction to a Survey of Missouri Place-Names" (by R. L. Ramsay, A. W. Read, and E. G. Leech, *Univ. of Missouri Studies*, Vol. 9, No. 1, 1934) describes the organization and methods of investigation in the state and presents the results for seven areas. An interesting chapter deals with problems still unsolved.

William A. Read, who includes in his "Louisiana-French" (*Louisiana State Univ. Studies*, No. 5, 1931) a section on Indian place names, has also made a study of Florida place names of Indian origin (Florida Place-Names of Indian Origin and Seminole Personal Names, *Louisiana State Univ. Studies*, No. 11, 1934).

Since this note was written "Research in American Place-Names since 1928" by Professor Read has appeared (*Zeitschr. für Ortsnamenforschung*, Vol. 10, 1934, pp. 222–242). It is in essence a bibliography with critical notes and a tempting mélange of examples.

EUROPE

Peat Bogs and Peat Deposits in France. Under the title "Documents cartographiques sur les tourbières actuelles et préhistoriques de France" (*Comptes Rendus Congrès Internatl. de Géogr., Paris, 1931*, Vol. 2, No. 2, 1933, pp. 771–797, with separate maps) Pierre Chouard summarizes the geography of peat and peat bogs in France by means of a series of maps. The general map distinguishes between peat deposits and active peat bogs: The former are abundant in the coastal region and not infrequent elsewhere. Active peat bogs are grouped into sphagnous, hypnaceous, and herbaceous. Genetic classification is not attempted, but the general calcifuge character of *Sphagnum* and the contrasting relation of *Hypnum* are suggested. A total of 926 deposits and bogs are listed by location and name.

The present distribution of twenty-eight species of Arctic plants, considered as glacial relicts, shows them richest in the Jura, Central Massif, Auvergne, and the Alps, with outliers even on the plains. In contrast, Atlantic species are most abundant in the west of France.

Sphagnous bogs are classified according to their present floristic composition. *Sphagnum* accompanied by euatlantic species occurs in western France, shading off into subatlantic, boreal, and arctic towards the northeast, in particular towards the Jura and Alps. The latter show unique arctic-alpine bogs. In the higher Pyrenees are also found northern bog communities.

One series of maps shows sites of fossil discoveries of artifacts, animal and plant remains, and microfossils, particularly pollen. Such studies are admittedly much less thorough at present than in northern Europe, but they are not without significance. Culture remains ranging from paleolithic to medieval have been discovered and have been of material assistance in dating deposits. Gross fossils have heretofore been mainly of service in shedding light on the mode of peat deposition. Pollen analysis, although not exhaustive, has shown a general order interpreted as follows: Birch and willow, followed by pine—pre-Boreal; Hazel maximum, advance guard of deciduous forest—Boreal; Mixed oak (oak, linden, elm)—Atlantic; Beech and maple, followed by present forests—sub-Boreal, sub-Atlantic. Variations are

shown in a table. It may be noted that the terms employed for periods are apparently used as measures of time rather than in a strictly descriptive sense for climate. The record for forest history cannot be carried back farther than about 10,000 years, a circumstance that applies in the United States as well as elsewhere in Europe.

The final chart, showing conditions of peat formation at successive periods of post-glacial time, is interesting, although provisional. This process began on the west coast. On the plains it was delayed until after the xerothermic period and is at present regressive there. In the mountains toward the north and east it naturally followed the retreating ice, mainly in depressions, later, however, giving rise to raised bogs.

The author's intelligent handling of the matter of glacial relicts is noteworthy. There is no crude assumption that these have been growing *in situ* since the ice left. Significant, too, in connection with this paper is Keller's recent statement regarding the entrance of beech into the Jura: "Wieweit dieser atlantische Baum durch die Vereisung nach Westen gedrängt worden ist, darüber werden uns die Untersuchungen der französischen Moore Auskunft geben" (Die Grundzüge der nacheiszeitlichen Waldentwicklung in der Westschweiz, *Berichte über das Geobotanische Forschungs-Institut Rübel*, 1933, Zürich, 1934, pp. 33–40).

The paper concludes with a systematic program for peat research along analytic, experimental, and synthetic lines. The need for promptness and coöperation is stressed—an appeal that strikes a responsive chord from those interested in similar problems in the United States.

PAUL B. SEARS

The Reform of Internal Boundaries in Hungary. In "Administrative Boundaries and the Rationalisation of the Public Administration" (*Inst. of Public Admin. Publs. No. 3 [A; Econ. Geogr. Publs. No. 9*, Budapest, 1932) Gyula Hantos presents a series of maps showing the territorial distribution of various public services and administrative functions—education, public health, justice, traffic regulation, labor exchanges, and the like. Superimposing the maps "to discover which are the stronger and more frequent boundaries" reveals a state of chaos. "The various distributions have been made quite independently of one another." On individual maps proportion seems to be lacking; districts large and small in population lie side by side; the centers of many are difficult of access. Accessibility is indicated on a set of five maps showing the "half-day circuit" from given centers, i.e. "that territory starting from which not earlier than 4 a. m. and spending 3 hours during official hours in the respective centre we can reach home again by 2 p. m." Among other things this brings out the "neglected character of that administration" south of the Budapest-Nagykanizsa line and the "obstructive character of the winding Tisza, with its inundation areas." Maps of the "whole-day circuit" display the overwhelming advantage of Budapest. Rationalization of the territorial limits of the state's functional activities should include decentralization of the central authority. Between Budapest with its million people and the next largest city, 135,000, is a "horrible gulf."

The Bases of Polish Agriculture. Poland is an area in which there are striking agricultural contrasts, although the climatic characteristics, except in the vicinity of the High Tatra, are relatively uniform. Perhaps political and cultural circumstances have played as great a part in affecting the type of agriculture as the natural environment. It may be observed that the pre-war German portions of Poland, constituting 11.3 per cent of the entire area of the country, produce about one-fifth of the wheat, barley, rye, and potatoes and 62 per cent of the sugar beets (O. E. Heuser: Die Produktionsgrundlagen der polnischen Landwirtschaft, *Berichte über Landwirtschaft*, Vol. 17 (N.S.), No. 3, 1933, pp. 429–465).

Poland's rural districts are sparsely populated, although 75 per cent of the people

are engaged in agricultural pursuits. Much of the labor is still done by hand and in general comes near to the primitive. The best lands are located in the southern and southeastern parts, the "black earth" soils of the latter region contributing much to its productivity. In the east is a considerable area of poor drainage reaching its climax in the Pripet marshes. Unfortunately, financial means are lacking to convert these wet soils into profitable farm lands for intensive cultivation. Consequently an extensive farming of a rather crude type yields small crops and leaves the farmers close to the poverty line.

Of the total area of Poland, 50.3 per cent is arable land, 10 per cent is in meadow, 7.2 per cent in pasture, 22.2 per cent in forest, and 10.3 per cent is unoccupied. The small number of livestock supported on the land may be remarked: except in the case of horses, livestock production in Poland is about the lowest among all European countries. The number of horses per unit area is, however, virtually equal to that of Germany and Belgium, the two largest European producers. In the absence of good roads and mechanical power the horse renders an effective service on the farms and in the villages.

In spite of the diversity of crop production it is possible to divide Poland into eleven agricultural regions. Those in the northeastern districts are most unfavorable for cultivation, whereas the western areas are especially well suited to it. The southern regions range from fair to good. However, the agricultural status of any part is first of all a factor of the cultural level of its people. For example, in western Poland, former German territory, the yield of wheat per hectare is as high as 79.7 kilograms, whereas in the vicinity of Kraków on soils classified as much better than in Poznań the yield is only 9.3 kilograms. Again, note such an indication as the fact that in Poznań every farm of 50 hectares or more is equipped with a sowing machine, but in the vicinity of Wilno among 100 farms of this size a total of only eight sowing machines could be found.

EUGENE VAN CLEEF

AFRICA

The Soil-Erosion Problem in Eastern Africa. "We are thus confronted with the paradoxes that tsetse-fly is a blessing and water a curse. Where there is water, cattle are concentrated; they eat the grass—seeds, roots and all. With the increase of cattle, the soil cover is progressively removed, and erosion sets in." "To-day two-thirds of Tanganyika are under tsetse-fly, and in that two-thirds erosion merely follows the slow natural course. There is no doubt that two-thirds of Tanganyika have been preserved by the fly from erosion and ruination at the hands of the native population." These quotations are from a discussion of soil erosion in Africa, where, under the settled conditions attendant on European rule, the general increase in the native population and in livestock is making the problem one of "urgent importance." In the opinion of C. W. Hobley, whose long experience on that continent qualifies him to speak, soil erosion and control of the tsetse fly are the two greatest problems in Africa today. He presents the general problem in a paper entitled "Soil Erosion: A Problem in Human Geography" (*Geogr. Journ.*, Vol. 82, 1933, pp. 139–146). The case as it applies to Kenya Colony in particular is presented by A. M. Champion in "Soil Erosion in Africa" (*ibid.*, pp. 130–139). Mr. Champion's conclusion also bears quoting: "In approaching this problem and recommending immediate measures the greatest caution is needed. Methods which have proved effective in one country may not in another. The first step which is required is regulated and systematic research by men competent to undertake the work."

The need of considering the regional aspects of soil erosion is illustrated in A. J. W. Hornby's study "Denudation and Soil Erosion in Nyasaland" (*Nyasaland Protectorate Dept. of Agric. Bull. No. 11 (N.S.)*, 1934). Many of the Nyasaland soils, such as those of the red-loam group, are not highly erosive; while the subtropical

black earths and the tropical chernozems, which are more erosive, are so situated and so protected by vegetation as yet that their natural erosivity is mitigated. Furthermore, in central Nyasaland, at least, the rainfall is of comparatively low intensity (A. J. W. Hornby: Climate of Central Nyasaland, *Nyasaland Protectorate Dept. of Agric. Bull. No. 9 (N.S.)*, 1933). However, parts of the protectorate are very densely peopled for Africa—even taking the southern province as a whole, there are 77 people to the square mile, with one-quarter of the area definitely infertile —and nomadic cropping and destructive methods of cultivation are prevalent. Mr. Hornby describes these methods and measures for their alleviation.

Land Classification from Aerial Photographs. The value of aerial photographs in land classification has been put to the test in Northern Rhodesia (C. R. Robbins: Northern Rhodesia; An Experiment in the Classification of Land with the Use of Aerial Photographs, *Journ. of Ecology*, Vol. 22, 1934, pp. 88–105). Supplied with oblique and vertical aerial photographs by the Aircraft Operating Company, Ltd. (see C. K. Cochran-Patrick: Aerial Reconnaissance Mapping in Northern Rhodesia, *Geogr. Rev.*, Vol. 21, 1931, pp. 213–220), Captain Robbins spent three months in the field and successfully covered nearly 3000 square miles of territory—a strip adjoining the railway between Chisamba and Kafue. Eight types and 25 subtypes of land were recognized and their boundaries mapped. The author's conclusion is that "identification on the ground, without the use of aerial photographs . . . would have been an immense labour and would, moreover, have demanded years of ground survey to have placed them reasonably accurately on a map." There can be picked out with certainty the areas containing the highest proportion of good arable lands, i.e. those worthy of first attention for European settlement. Other types distinguished are: arable land in smaller blocks mixed with land more suitable for pastoral purposes; soils of varying depths, often with heavy bush; forests on flat limestone and sand areas, types largely unsuitable for agricultural purposes; hill forest on shale, also unsuited to agriculture but demanding protection for water-supply purposes; types of grassland, with or without trees, subject to waterlogging. Captain Robbins, a forester by profession, stresses the need of experience in the interpretation of aerial photographs, a subject that presents difficulties to the uninitiated.

The Cartography of Italy's Libyan Colony. An account of the history and status of Libyan surveys by Colonel E. De Agostini appears in the June, 1934, number of the *Rivista delle Colonie Italiane.*

Before the Italian occupation of the country in 1911–1912 little or no mapping had been done with the exception of some general hydrographic surveys along the coast by the British and French. The war curtailed the work started by the Italian government, and, save for desultory surveying born of military and political needs, it was not until 1921 (in Cirenaica) and 1926 (in Tripolitania) that a cartographic program based on modern methods was instituted. Coöperating with the Istituto Geografico Militare and the colonial governments, the Istituto Idrografico della R. Marina undertook a geodetic survey of the coast, tying it up with those of Egypt and the French colonies of Tunis and Algeria, and eventually uniting the African continent with Europe. The resulting charts show decided differences from the earlier British and French surveys based on obsolete methods of survey. There are three general charts of the Libyan coast on the scale of 1 : 120,000 and fifteen detailed ones on the scales of 1 : 320,000 and 1 : 550,000—a remarkable achievement for such a short period.

With the triangulation established, it was possible to progress with the topographic surveying, and maps are being issued on the scales of 1 : 25,000, 1 : 50,000, and 1 : 100,000. These are limited to the coastal regions, which constitute the main

interests of the colony. Reconnaissance surveys, however, are rapidly being developed for the interior parts. The index map shows such surveys (1 : 400,000) executed for the Kufra and Owenat regions. In connection with the latter, reference may be made to the recent settlement of the Sudan-Libyan frontier (*The African World*, July 28, 1934, p. 69).

Nigerian Lake Chad. A contribution to the perennially interesting problem of Lake Chad (compare *Geogr. Rev.*, Vol. 19, 1929, pp. 157–158) is made by C. Raeburn and Brynmor Jones in "The Chad Basin: Geology and Water Supply" (*Geol. Survey of Nigeria Bull. No. 15*, 1934). Their report deals mainly with the Nigerian part of the basin, roughly one-tenth of its 650,000 square miles. The conclusion as regards desiccation is: "Local desiccation due to river capture, to the progressive infilling of Chad and to the loss of water in rivers caused largely by dumping of alluvium from eroded farmlands is in train, but there is no evidence of any regional desiccation caused by diminution of rainfall and indeed everything rather tends to prove that the present era is relatively humid. The complete disappearance of Chad would be serious but its effect would not be catastrophic for it is unlikely that Chad has any influence on rainfall except in its own immediate neighbourhood, and it is known that it has no influence on the subsurface, which is the important, water supply of the Nigerian portion of the Chad Basin."

The improvement of wells, the main source of water supply, is discussed. The recent opening up of the region by railway and motor roads has made economically possible the construction of government wells lined with reënforced concrete. These represent a great saving of labor and life. "In those parts of the grasslands where water is deepest, about forty fathoms, there seems to be a tendency for the people to move to areas of shallower water. This is due to the collapse of the deep, native-dug wells and to the absence of slaves to dig new ones or repair the old."

ASIA

New Administrative Division of the Kazak Autonomous Soviet Socialist Republic. The Kazak Autonomous Soviet Socialist Republic is the second in size (second only to the Yakut Autonomous Soviet Socialist Republic) among the autonomous republics forming the agglomeration of states known as the Russian Socialist Federal Soviet Republic. It covers an area of 2,814,600 square kilometers—an area equal to that of the Argentine Republic—with a population of 7,058,500 (as of January 1, 1931).

The population of the Kazak Autonomous Soviet Socialist Republic by nationalities is made up as follows: Kazaks, 58.8 per cent; Russians, 20.6; Ukrainians, 14.0; Uzbeks, 2.1; others, 4.5. The name "Kazak" as applied to the people inhabiting the steppe region of Russian Central Asia was formerly practically useless as an ethnographic classification. The Kazaks were generally known as Kirghiz or Kirghiz-Kaisak when the autochthonous Kirghiz people inhabiting the basin of Lake Issyk, and the Chu and Talas rivers were known as the Kara-Kirghiz (i.e. the Black Kirghiz). To be quite correct, however, the people at present inhabiting the Kazak Republic should be called Kazaks and the name Kirghiz applied only to those previously known as Kara-Kirghiz. The word "Kazak" is the name by which this people call themselves, and it is derived from two words, namely "kaz" meaning "goose" and "zag" meaning "raven," the two combined indicating the qualities of free and untrammeled independence proper to errant nomads of the steppe.

At the time of its formation at the end of 1924 the Kazak Republic consisted of six of the old Russian governments (provinces) and part of another. In 1930 the old system of division was abolished, and the Republic was divided directly into 121 regions (*rayon*) with 3735 communes (*selsoviet*). In 1932 it was divided anew into 6

FIG. 1—New administrative divisions of the Kazak Autonomous Soviet Socialist Republic. Scale 1 : 30,000,000.

territories (*oblast*), following their natural boundaries and closely adhering to the prerevolutionary system of division into governments. The present administrative divisions with their capitals are shown on the map, Figure 1.

N. KRIJANOVSKY

Volcanoes of Kamchatka. Though the Kamchatka volcanoes constitute the greatest group of active volcanoes on the Eurasian continent, they have attracted comparatively little scientific attention. In 1932 P. T. Novograblenov, known for his explorations in Kamchatka, published a "Catalogue of the Volcanoes of Kamchatka," giving a brief characterization of the individual volcanoes and straightening the confusion that has existed in their nomenclature. The writer of this note has translated the catalogue into English (Volcanoes of Kamchatka, *Bull. Geol. Soc. of America*, Vol. 45, 1934, pp. 529–549). He has also added geographical coördinates and has compiled a map showing the location of the volcanoes (scale, 1 : 4,500,000; scale of the original, 1 : 1,250,000).

Three longitudinal volcanic zones can be recognized in Kamchatka. The oldest, with volcanic activity dating back to the Pliocene, is in the west; here are 16 old eroded volcanoes and laccoliths. In the central chain are 37 volcanoes. In the east no less than 74 volcanoes are concentrated. Among the volcanoes of the eastern group is Klyuchevskoi, one of the truly great volcanoes of the world and still violently active. During recent eruptions the sharp summit collapsed into the crater, destroying the symmetry of its wonderfully regular cinder cone.

In "The Eruption of Patsana and Faina in Kamchatka" (*Bull. Russian Geogr. Soc.*, Vol. 65, 1933, pp. 387–401) Novograblenov reports the formation of two new parasitic craters on the northeastern slopes of Klyuchevskoi some sixteen kilometers from its principal crater and at an altitude of 550 meters above sea level. Since the close of the seventeenth century there have been many violent eruptions in Klyuchevskoi, but the eruptions that have produced its large number of parasitic craters, of which there are now more than 20, have not heretofore been recorded.

The eruption that brought forth the Patsana crater was preceded by earthquakes, beginning in August, 1931, and continuing for a period of more than five months. Only the strongest shocks and tremors were recorded by the local authorities, such shocks at times reaching a force of 6–7 points according to the Rossi-Forel seismic scale. On January 23, 1932, the earthquakes in the Klyuchevskoi region ceased

abruptly, and two days later the new little *sopka*, Patsana, was observed. A huge column of smoke was seen to rise from its center and reach a height of about 12,000 meters. A strong explosion was heard. Three days later a violent magmatic explosion propelled a column of red-hot bombs and lapilli about 1000 meters into the air. Explosions and eruptions continued until the middle of February, when the explosions gradually subsided, though the emission of smoke and gases and the ejection of lava proceeded apace. It is estimated that the stream of basaltic lava from Patsana reached 5 kilometers in length and averaged 400 meters in width and 60 meters in thickness. By the end of May the Patsana cone was quiescent.

On June 29, 1932, the flat subalpine meadow close to Patsana was rent asunder by the birth of the second parasitic cone, Faina. The new crater was continuously active through July, August, and September. Even as recently as last year it remained quite active. Discharges of lava took place from the middle of July, 1932, to September 20 and covered an area of some five square kilometers with a layer averaging about 30 meters in thickness. Novograblenov classifies the eruptions of Patsana and Faina as of the Stromboli type.

N. KRIJANOVSKY

POLAR REGIONS

Progress in Research in Antarctic Waters. The extraordinary rise in Antarctic whaling in the last decade, culminating in the production of more than 3,600,000 barrels of oil in the 1930–1931 season, has occasioned anxiety as regards the whale and the industry. The excessive catch of 1930–1931 brought an immediate retribution in the glutting of the market. Operations were very limited the succeeding season (little more than 800,000 barrels), and quotas have been in effect among the whaling companies for 1932–1933 (2,450,000 barrels on an improved yield) and 1933–1934 (about 2,400,000 barrels, although 1,800,000 barrels remained unsold from the last season). Details are given in *International Whaling Statistics* (Oslo) and the *Polar Record* (Cambridge, England). The conservationists, however, look to the framing of more adequate measures. A summary of the situation is given by Dr. J. T. Jenkins in "Whales and Modern Whaling" (London, 1932), a work written "in the hope that effective action may be taken in time to prevent the larger whales from total extinction."

Prosecution of the industry and conservation of the species alike demand more knowledge of the natural history and migration of the whales. Progress in filling this need is being made by both commercial companies and scientific bodies. By agreement with the Discovery Committee in 1923 the Whaling Committee of the Norwegian government decided to concentrate its studies on the North Atlantic fisheries (see, for example, "Whales and Plankton in the North Atlantic," *Rapports et Procès-Verbaux des Réunions, Conseil Perman. Internatl. pour l'Expl. de la Mer*, Vol. 56, 1929), but valuable data have been collected by the Norwegian companies in the Antarctic in the prosecution of their routine labors and in specially organized expeditions. Following Cook and Bellingshausen, Biscoe in 1830 made the third circumnavigation of the Antarctic. It is no coincidence that the next circumnavigation, accomplished 100 years later (unless one considers Ross's three Antarctic expeditions to constitute a circumnavigation), should also have been "conceived and paid for by a merchant with more than a commercial interest in the Antarctic." The story of the circumnavigation in 1930–1931 of the *Norvegia*, Consul Lars Christensen's research ship, has been told by Major Isachsen in the *Geographical Review* (Vol. 22, 1932, pp. 83–96) and retold in greater detail in "Norvegia rundt Sydpollandet" (reviewed in this number of the *Review*). Another recent contribution presenting scientific results from earlier voyages of the *Norvegia* is Håkon Mosby's "The Sea-Surface and the Air" (Norske Videnskaps-Akademi i Oslo, Scientific Results of the Norwegian Antarctic Expeditions 1927–1928 et sqq. . . . , No. 10,

1933). Consul Christensen's work continues. He himself participated in the voyages of the last two seasons. The Society has received from him charts of the *Thorshammer's* route with soundings on the 1932–1933 expedition. On the 1933–1934 expedition new land, Princess Astrid Land, was sighted a little south of the Antarctic Circle, in about 86° 45′ E.

The law of 1929 required Norwegian companies engaged in whaling to keep strict records of their activities. These are turned over to the Biological Laboratory of the University of Oslo. An analysis of data available for the seasons 1929–1930 and 1930–1931 has been made by Johan Hjort, J. Lie, and Johan T. Ruud (Norwegian Pelagic Whaling in the Antarctic, I: Whaling Grounds in 1929–1930 and 1930–1931, *Norske Videnskaps-Akad. i Oslo, Hvalrådets Skrifter*, No. 3, 1932). The distribution of the catch is displayed not only in tables but most graphically in a series of maps. In connection with the distribution of the catch reference should also be made to an important paper by Sir Sidney F. Harmer on "Southern Whaling" (*Proc. Linnean Soc. of London*, Session 142, 1929–1930, pp. 85–163). Another study by Johan Ruud, who accompanied Professor Hjort on the *Vikingen*, 1929–1930, deals with the krill, or whale food (On the Biology of Southern Euphausiidae, *Hvalrådets Skrifter*, No. 2, 1932). Of special interest is the chapter on "The Plankton Conditions of the Whaling Grounds and Their Relation to Ocean Currents," in which comparison is made with the northern hemisphere. The author concludes by emphasizing the connection between the feeding grounds and dynamic oceanographical phenomena: concentrations of krill are found "in the areas of convergence, in backwaters, in the vortices of mixed layers, and at the centre of areas where there is a cyclonic movement."

The labors of the Discovery Committee are likewise productive of results. The Committee's new research ship, the *Discovery II*, also accomplished a remarkable circumnavigation on her second commission in 1931–1933 (D. D. John: The Second Antarctic Commission of the R.R.S. *Discovery II*, *Geogr. Journ.*, Vol. 83, 1934, pp. 381–398). The Antarctic work began in November, 1931, with the running of oceanographical sections in the Falklands sector between the edge of the ice and the Antarctic Convergence as the meeting between the heavy Antarctic surface water and the lighter sub-Antarctic surface water is termed. (See H. U. Sverdrup: On Vertical Circulation in the Ocean Due to the Action of the Wind with Application to Conditions within the Antarctic Circumpolar Current, *Discovery Reports*, Vol. 7, 1933, pp. 139–170; also A. J. Clowes: Influence of the Pacific on the Circulation in the South-west Atlantic Ocean, *Nature*, Vol. 131, 1933, pp. 189–191). Vertical circulation takes place here with biological implications of great importance. The boundary is easily detected by the change in temperature and by the differences in species of *Euphausia*, the whale food. Mr. John adds: "But we, whether sailors or scientists, know and will remember the convergence best in another way: as the line to the north of which we felt one day, at the right season, after months in the Antarctic, genial air again and soft rain like English rain in the spring. . . . In the southernmost lands in the sub-Antarctic, the islands about Cape Horn, the earth smells as earth should smell and as it never does in the Antarctic." On January 19, 1932, in the Weddell Sea, the *Discovery II* reached latitude 70° S., north of Caird Land. There she came up against impenetrable pack. Mr. John observes that other vessels have had the same experience in the locality, and Mr. Wordie thinks it points to land or an ice tongue projecting eastward.

In March, 1932, the *Discovery II* was docked and repaired in Simonstown (the Cape) before starting on a zigzag course between the ice edge and the Subtropical Convergence—to 70 miles off Enderby Land, to Fremantle, to 100 miles off Banzare Land, to Melbourne, to Auckland and Wellington, to the edge of the ice in 62° S. in the Ross Sea sector, to near the Subtropical Convergence in 41° S. and 126° W., then to a position 63° 57′ S. and 101° 16′ W., where fuel shortage compelled return.

Magallanes was reached on October 5. Never before had such long cruises been made in such high latitudes during the winter season. A second survey was undertaken in the Falklands sector and then a survey of all of the South Orkneys with the exception of Laurie Island, mapped by Bruce in 1903. A cruise to 69° 22′ S. and 9° 37′ E. completed the circumnavigation. The data collected by the *Discovery II* on this command include 9000 echo soundings. Paying tribute to modern equipment and technique, Mr. John notes that under the old methods the taking of this number of soundings would have entailed stopping the ship for a total of more than a year! The *Discovery II* has completed her 1933–1934 season's work, one of the main objectives of which was to investigate the extreme south of the Pacific sector of the Antarctic, and has left Cape Town again (August) for the Antarctic.

PHYSICAL GEOGRAPHY

Gravity Survey of the West Indies. The East and West Indies are probably two of the most interesting regions in the world from a geophysical viewpoint. Crustal movements of more than ordinary proportions are undoubtedly taking place in both of these areas. On the continents orogenic studies have necessarily been confined to a large extent to an interpretation of the records found in the rocks of vertical or horizontal crustal movements that took place millions of years ago. In these island areas we are undoubtedly dealing with recent orogenic movements and forces.

One of the most effective methods for making a geophysical study of these active areas is by means of gravity measurements that may now be made at sea with the modern Meinesz apparatus with an accuracy almost equal to that obtained at land stations. Several hundred gravity stations have already been determined in the East and West Indies, but many more are needed, especially in the West Indies. The second gravity-at-sea expedition to the West Indies (The Navy-Princeton Gravity Expedition to the West Indies in 1932, U. S. Hydrographic Office, Washington, 1933) has added greatly to our knowledge of this region, but much remains to be done before geophysicists can be at all confident of their interpretations of the data. Some of the tentative conclusions based on the data now available are very clearly set forth by Dr. Harry H. Hess, one of the authors of the report cited.

The isostatic gravity anomalies that have been derived from the observed data seem to be about what might be expected if there is postulated a great crustal movement in an eastward direction of the Caribbean region with a probable front in or near the Lesser Antilles. This movement is also indicated by the great fault scarps of southeastern Cuba and by the formation of the Bartlett Deep, both of which are near the northern edge of the moving block.

The outstanding negative gravity anomalies north of Puerto Rico and Haiti form a belt smaller than, but very similar to, the long negative belt found by Dr. F. A. Vening Meinesz in the East Indies and may possibly be explained, as Dr. Meinesz suggests, by a great downward fold of the earth's crust partly filled with sediments. The western end of the negative belt in the West Indies has apparently been found near the eastern end of Cuba, but the eastern end of the belt is still undetermined. It is surmised that the belt may bend southward east of the Virgin Islands and perhaps follow the trend of the Lesser Antilles nearly to South America. Land determinations on these islands and gravity-at-sea measurements in the surrounding waters would seem to give the data most needed for future attacks on this problem.

Altogether there are now more than 200 gravity stations in the West Indies, about equally divided between land and sea determinations. Almost all of this work has been done by the coöperation of different scientific organizations and individuals. The sea work, of course, must depend on the coöperation of the United States Navy or the navy of some other country, as the Meinesz apparatus can be used effectively only on a submarine.The gravity work on the islands themselves can be done

efficiently by the Coast and Geodetic Survey, as it is equipped with modern gravity apparatus and a trained personnel, but other geophysical studies of the region would be greatly accelerated and enhanced by the coöperation of scientists from other organizations, as in previous work in the West Indies. It is hoped that there will be no long delay in completing at least the general survey of this interesting area.

C. H. Swick

The Cycle of Temperature of the Middle Atlantic Bight. The first studies of the temperature of our Atlantic shore line used data secured from lighthouses and lightships and thus were applicable to the shallow water having a depth of 30 feet or less (compare "Thermal Areas in the Atlantic Coastal Waters of the United States," *Geogr. Rev.*, Vol. 23, 1933, pp. 487–488). Using all data available, chiefly from the cruises of the U. S. Bureau of Fisheries' *Albatross II* and the Woods Hole Oceanographic Institution's research vessel *Atlantis*, H. B. Bigelow has now extended the area to all the water over the continental shelf, subsurface as well as surface (Studies of the Waters on the Continental Shelf, Cape Cod to Chesapeake Bay: I, The Cycle of Temperature, *Papers in Physical Oceanog. and Meteorol.*, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, Vol. 2, No. 4, 1933).

The winter minimum is reached in late February or early March, with the coldest water lying nearest the coast and the isotherms roughly paralleling the trend of the coast line. Transversely, the temperature normally increases from about 35° F. (locally colder) next to the land to about 48° F. at the edge of the shelf off southern New England; from 37° to 50° F. off Cape May; from 41° to 50° F. off Chesapeake Bay. The water is nearly homogeneous in temperature from surface to bottom over the entire continental shelf as far out as the 300-foot contour line.

Springtime warming is slow and irregular in commencing, for the shallow water warms through its whole column. Subsurface water midway out on the shelf often continues to cool even after warming has begun at the surface. In early May the surface water eastward from New York develops a definite thermocline, while southward the water continues to warm throughout its entire thickness. The winter thermal barrier (compression of isotherms) at Cape Hatteras begins to loosen, and by the end of the rapid vernal warming period the barrier has completely broken down. Over the eastward reach of the bight springtime warming is often delayed and complicated by intrusions of cold water from the Nantucket Shoals region, which, however, seldom drift as far westward as the offing of New York.

Except in the Nantucket Shoals region, the summer warming continues at a rapid rate over the whole area during June and July. The thermocline increases in steepness owing to the rise in warmth. Maximum temperatures are attained in early August, and these high values continue for nearly a full month afterwards. The Nantucket Shoals region is quite variable in temperature—a condition ascribable to tidal mixing, turbulence, and local upwelling; but temperatures are always several degrees lower than those southward or westward. Between Martha's Vineyard, whose maximum is about 68° to 70° F., and Chesapeake Bay offing, whose maximum is about 75° to 77° F., there exists a latitudinal gradient of 7 to 9 Fahrenheit degrees, and transverse to the shelf a gradient of less than 5 Fahrenheit degrees is produced. At the commencement of autumnal cooling the thermocline is most pronounced with a greater difference in temperature, top to bottom, off southern New England. Over the whole area the difference from top to bottom ranges between 16 and 29 Fahrenheit degrees, and the greatest temperature change lies between the 50 and 100-foot depths. A cold bottom tongue lies over the shelf between the 100 and 250-foot contours, as the water is considerably colder than that on either side.

Cooling is well under way over the whole area by the latter part of September, except in the Nantucket Shoals area, where no perceptible cooling occurs until late

October or even early November. At this time, when the northern thermal barrier at Nantucket Shoals is erased by having surface temperatures similar to those to the east and west, the Cape Hatteras barrier is again set up. By mid-December the coldest water is close inshore and the winter condition of isotherms paralleling the coast has been definitely established. Heavy weather, turbulence, and lack of a warm protective surface layer combine to produce homogeneous temperatures through a considerable depth.

In conclusion Bigelow states that "no thermal evidence has been found of any widespread influx of warm coastal water into the region from the south, of any floodings of the surface with pure oceanic water of high temperature, nor of upwellings onto the shelf of cold abyssal water, such as have sometimes been postulated in the past on theoretic grounds."

PHIL E. CHURCH

Marquesan Meteorology. Anyone asked to point to a region of extreme climatic monotony might well select the central Pacific Ocean in latitudes 8° to 10° S. The validity of this selection rests less secure since the publication of "Marquesan Meteorology" by John B. Leighly (Notes on the Meteorologic Observations Made in the Marquesas Islands by the Pacific Entomological Survey During the Years 1929–1932, *Univ. of California Publs. in Geogr.*, Vol. 6, No. 4, Berkeley, 1933, pp. 147–172), who presents new tabular data together with a concise but highly significant analysis of climatic conditions and a reasonable approach to the problem of forecasting dry and rainy spells.

A series of semihourly observations at Taiohae, in about longitude 140° W. and latitude 9° S., indicated, for May 19–22, 1931, a mean daily range in temperature from 23.8° C. to 30.4° C., with maximum at 11 o'clock, and in relative humidity from 98.7 per cent to 75.0 per cent, with minimum at the same hour. These observations were also useful in establishing a close approximation for daily mean temperature (or relative humidity) according to the formula

$$\text{Mean} = \tfrac{1}{4} [\, \alpha_6 + \alpha_{12} + 2\,(\alpha_{18})\,]$$

in which α_6, α_{12}, and α_{18} represent temperatures (or relative humidities) observed at those hours. The annual curve of temperature at Atuona ranges between a maximum of 26.4° C., in March, and a minimum of 25.0° C., in August. A delayed minimum is related to the upwelling of cold waters in equatorial regions. Though some irregularities in the annual curve may be due to the cooling effects of cloud and rain, the principal control of the seasonal cycle, other than the annual insolation curve, is the temperature of the ocean surface.

It is in precipitation that the greatest climatic irregularities are to be found (Atuona rainfall: May, 1930, 31.7 millimeters; May, 1931, 513.3 millimeters). In dry years maximum rainfall occurs regularly during the southern winter and may be provisionally ascribed to uncharted extratropical cyclonic storms of the southern hemisphere. Less regularly distributed is the precipitation of wet years, with something resembling a maximum in the season January-March. An examination of pressure conditions over adjacent parts of the Pacific indicates that dry spells are periods of increased westward gradient along the equatorial trough of low pressure; rainy spells are periods of decreased gradient in the same direction. Westerly gradients of the trough are conditioned by the intensity of anticyclonic activity in the south. Active thrusts of Antarctic air cause pressure gradients to steepen toward the equatorial trough and are associated with heavy rains of the year-end season. Thus the annual rainfall of mid-Pacific islands of the equatorial belt is primarily controlled by atmospheric processes of the southern hemisphere.

Though the equatorial trough migrates with the march of seasons, with concomitant changes in pressure, temporary variations occur within the trough itself. Centripetal gradients form toward loci of active condensation in the vicinities of islands.

Atmospheric instability, hence rainfall, is greater when surface water is warmer, and stability suggesting that of the "cold water coasts" of middle latitudes arises during seasons of conspicuous upwelling. As upwelling varies inversely with the force of east winds, periods of steep westward pressure gradient should be periods of low water temperatures and hence unfavorable to rain. A possible method of forecasting seasonal rainfall for mid-Pacific islands employs mid-year pressures at Darwin. High pressure in mid-year indicates with considerable certainty that high pressures will also occur six months later, at the year end. High year-end pressures in the western portion of the equatorial trough lessen the westward pressure gradient, hence conditions are favorable to heavy rainfall in mid-Pacific. Low mid-year pressures at Darwin are, similarly, unfavorable to heavy rainfall in mid-Pacific. Since a close correlation exists between heavy year-end and heavy annual precipitation at Malden Island and in the Marquesas, the forecast for one condition serves for the other as well.

Weather changes on the mid-Pacific islands resemble, in irregularity and sometimes in abruptness, those of middle latitudes, and until such time as synoptic methods may be employed in tracing their evolutions they will evade thorough comprehension.

RICHARD JOEL RUSSELL

HISTORICAL GEOGRAPHY

The Isle of Gold and the Isle of Silver. To the category of tales of mysterious "lost" islands belongs the legend of the Isle of Gold and the Isle of Silver. Edmond Chassigneux, in an article entitled "Rica de Oro et Rica de Plata" (*T'oung Pao*, Vol. 30, 1933, pp. 37–84), has recently reëxamined their story and has offered a new explanation of its origin.

After the Spaniards had established themselves in the Philippines, they greatly desired to find some port where their galleons might refit and revictual on the circuitous return voyage from Manila by way of the North Pacific to Acapulco. Hoping to help solve this problem, the learned monk Andrés de Aguirre, in the early eighties of the sixteenth century, wrote to the Viceroy of New Spain regarding an alleged discovery by a Portuguese ship. This vessel, according to the story, while on its way from Malacca to Japan was caught in a furious gale from the west that drove it eastward for eight days. Then the weather moderated, and the voyagers sighted two large islands. These, the captain thought, lay between latitudes 35° and 40° N. (i.e. off the northeast coast of Japan). Their longitude he was of course unable to fix. The discoverers named them "Ilhas de Armenio" for one of their own number, an Armenian merchant from Malacca. They were inhabited by a civilized people extremely rich in the precious metals. After a month of highly profitable trading the Portuguese ship returned home.

As a result of Aguirre's letter, the Viceroy sent an expedition in 1587 to seek the two "Isles of the Armenian"; but it failed to locate them, nor did it find another pair named on the chart "Rica de Oro" and "Rica de Plata." A second expedition sailing from Acapulco in 1611 under the famous Sebastian Vizcaino was equally unsuccessful. The Spaniards then gave up the search. It was next taken up by the Dutch, who sent out expeditions in 1637 and 1640. These, while adding greatly to the knowledge of the North Pacific area, likewise failed to find the missing islands. Later the quest was renewed by explorers of other nations, among them La Pérouse in 1787 and Krusenstern in 1804 and 1805. But no trace was found of the Isles of Gold and of Silver, and they were at length relegated to the realm of phantasy.

Nevertheless, M. Chassigneux thinks that the belief in their existence was due to a misunderstanding of an actual occurrence—the landfall made by the Portuguese ship. His arguments deserve consideration. He suggests, plausibly enough, that the

"violent gale from the west" can only have been the southern sector of a typhoon, for those storms, in the northern hemisphere, blow counterclockwise. On this theory, the Portuguese captain, instead of being forced eastward as he thought, was in reality carried around the arc of a circle, the storm leaving him in the neighborhood of the Loochoo Islands, far to the south of his original position.

M. Chassigneux then points out that, except for their latitude, the condition of those islands during the mid-sixteenth century tallies almost exactly with the description given of the "Isles of the Armenian." He suggests that the Portuguese captain, misled by the nontropical aspect of the islands upon which he had blundered, estimated that they must lie somewhere between the parallels of 35° and 40°—over ten degrees too far north. This identification presents certain difficulties. Thus, even allowing, with M. Chassigneux, that the captain may have lost his astrolabe in the gale, he must have known his position before the storm arose. Hence, if he believed that, after having been carried east for eight days, he was somewhere between the parallels named above, it follows that he was in about those latitudes when the tempest caught him. It seems unlikely, however, that he could have thought himself driving eastward all the time when in reality he was being blown along the arc of a circle, for his compass would have shown him the truth.

Again, Aguirre states that the ship was proceeding from Malacca to Japan. Therefore he must have believed that the voyage took place after the Portuguese had learned the way to the latter country, in or about 1542. But by that time they had been visiting the Loochoos for several years, so that the ship's company could hardly have failed to learn that they had reached a place already well known.

Finally, it seems impossible that this voyage could have given rise, as M. Chassigneux believes, to the legend of the Isles of Gold and of Silver; for in addition to these there appeared on the charts used in the voyage of 1587 those "of the Armenian" also.

The Portuguese captain's account of the islands he had found applies too closely to the Loochoos not to have had some basis in fact. His visit must, however, surely have occurred, if at all, before, and not after, his countrymen had reached Japan itself. Our difficulty is that we simply do not know what modifications the tale may have undergone before it was recorded, at second or third hand, by Aguirre. The story accounting for the curious name "Armenian" may easily be a true one. On the other hand, it may be an attempt to explain a native designation similar in sound but meaningless to the narrator. One of the Loochoos themselves is named Amami.

As for the Isles of Gold and of Silver, their legend seems likely to have had a far remoter origin. As M. Chassigneux himself reminds us, Pomponius Mela and Pliny locate them, as Chryse and Argyre, off the mouths of the Indus. And Japanese folklore has a tale of an Isle of Demons, whence an enterprising young hero, aided by certain grateful beast and bird helpers, carries off vast treasure and lives happily ever after.

C. W. BISHOP

Chinese Voyages in the Indian Ocean in the Early Fifteenth Century. The importance of China as a maritime power during the past two or three centuries has been almost negligible. Nevertheless, there have been periods in the course of the past two millenniums when she has maintained both commercial and political relations with many distant lands accessible only by sea. It is one of these epochs that Professor Paul Pelliot discusses at some length in a recent paper entitled "Les grands voyages maritimes chinois au début du XVe siècle" (*T'oung Pao*, Vol. 30, 1933, pp. 237–452).

During the years 1403–1433 the emperors Yung Lo and Hsüan Tê, the third and fifth rulers of the Ming dynasty, sent the grand eunuch Chêng Ho on seven voyages

to the south and west. In the course of these he entered into relations with Java, Sumatra, Siam, Malaya, Ceylon, Bengal, the Malabar Coast, the mouth of the Persian Gulf, the Red Sea, and the east coast of Africa.

The eunuch admiral's voyages, unlike those initiated by his European contemporary Prince Henry the Navigator, were not in any primary sense exploratory. The seas that he crossed had long been traversed. There appears to be no specific reference to sailing craft as such in the Chinese annals before the third century of our era. But the data recorded by Ptolemy regarding the southern coasts of Asia at least as far as the Gulf of Tonkin, together with statements in Chinese writings, make it certain that voyagers from the West were beginning to reach southern China around the commencement of the Christian era. These visits continued, and we know that by the beginning of the fifth century there existed a well developed trade between India and China, although little of it perhaps was conducted in Chinese ships. Chinese vessels may, however, have reached southern Arabia and the Persian Gulf before, or at all events not long after, the rise of Mohammed; and during the three centuries thereafter, under the great T'ang dynasty, trade between China and the Occident was active. From the tenth to the thirteenth centuries such intercourse was regularly carried on, by the Arabs more particularly, but also by the Chinese themselves: it was perhaps at this time that the mariner's compass came into use. Over the vast sea-borne traffic conducted under the Mongols, the Yüan dynasty of China, writers like Marco Polo and Ibn Batuta wax enthusiastic.

During this long period of about a millennium the Chinese had developed a type of seagoing craft probably superior in size and rig and general seaworthiness to anything that contemporary Europe could show. We have abundant evidence, from a variety of sources, that the larger vessels could carry several hundred men. These craft, with their lugsails extended by battens, could, notwithstanding their flat bottoms, lie several points closer to the wind than European ships before the invention of the jib. Their sole Occidental rivals in this respect of weatherliness seem to have been the light lateen-rigged caravels favored for exploration work by the Portuguese and Spaniards and whose type survives, little changed, in the present-day Arab dhow.

The expeditions of the Chinese admiral were affairs of incomparably greater magnitude than those dispatched from the Iberian Peninsula during the same century. They were conducted in armadas of great junks several tens in number—Chêng Ho is stated to have had under him on his initial voyage 62 vessels, manned by 27,800 sailors and soldiers. Vasco da Gama had on his first voyage, nearly a hundred years later, only four small ships and 118 men.

The fleets commanded by the great Chinese seaman were composed of what were known as *pao ch'üan* (literally "jewel ships"). The word *pao* is sometimes used figuratively, to describe anything fine or splendid. Professor Pelliot, however, gives good reasons for taking it here in its literal meaning; it indicates, according to him, that the primary purpose of Chêng Ho's voyages was to procure the precious stones and other riches of the Middle East—precisely, "of Ormuz and of Ind"—for the imperial court of the Mings.

Among the other duties laid upon the eunuch admiral were the assertion of his sovereign's supremacy in the Western Sea and the exaction of tribute. He also conferred titles and badges of rank upon those foreign rulers willing to pay the homage claimed by the Son of Heaven as his right from all earthly potentates. Nowhere, however, did the expeditions effect any permanent occupation. The Chinese, although wielding vastly greater resources and operating from a much less distant base, failed to set up a colonial empire like those founded in the immediately succeeding centuries by various European states and trading companies. When the Portuguese appeared on the Malabar Coast, at the very end of the fifteenth century, they found no Chinese there, but only dim and distorted recollections of their visits

of two or three generations before. It was not until they reached Malacca, a few years later, that the Portuguese came into actual contact with Chinese trading junks.

C. W. BISHOP

EDUCATIONAL GEOGRAPHY

Some Recent German Geographical Works of Comprehensive Scope. Geographical studies in Germany display a vitality little, if at all, affected by troubled political and economic conditions. Evidence of this is furnished not only by a large output of monographs and periodical articles but also by the sustained production of advanced textbooks and manuals of comprehensive scope. Some of these are wholly new; others, thoroughly revised editions of works that have already made their mark. All of them offer materials adapted to the use of American college teachers in preparing lectures.

Professor Max Eckert, author of a monumental treatise on cartography (Die Kartenwissenschaft, 2 vols., W. de Gruyter & Co., Berlin and Leipzig, 1921–1925), has written a new textbook, "Neues Lehrbuch der Geographie" (Georg Stilke, Berlin), which aims to cover the entire field of geography within a relatively limited space. Eckert believes that the majority of German *Lehrbücher* have grown too large, formidable, and detailed for the student beginning serious geographical work. The "Neues Lehrbuch," however, is no primer. The parts that have appeared to date—Volume 1, 1931, on general geography, and Volume 2, Part 1, 1933, on the regional geography of Europe—comprise no less than 1130 pages.

The first two volumes—the only ones so far published—of Professor Alfred Philippson's "Grundzüge der allgemeinen Geographie" (Akademische Verlagsgesellschaft, Leipzig) have been reissued in a revised edition (Vol. 1, 1933; Vol. 2, Part 1, 1930; Part 2, 1931). This work is notable for the clarity and simplicity of its style and the convenient arrangement of its contents. The first volume covers mathematical geography, meteorology, and climatology, and the second geomorphology. The author hopes ultimately to complete the work with volumes on oceanography, biogeography, and human geography.

Eckert's "Neues Lehrbuch" is entirely without illustrations, and in Philippson's book the illustrative material is restricted to diagrams and to three world maps showing temperature zones, climatic provinces, and tectonic regions. The quality of German school atlases—such, for example, as the Sydow-Wagner "Methodischer Schul-Atlas" (Justus Perthes, Gotha) or Diercke's "Schulatlas für höhere Lehranstalten" (Westermann, Brunswick)—is so high and their use so widespread that both Eckert and Philippson felt justified in omitting maps on the assumption that students will have an atlas constantly before them. Photographs have been dispensed with, perhaps because excellent photographs are readily available in the more popular regional geographies such as the "E. von Seydlitz'sche Geographie: Hundertjahr-Ausgabe" (3 vols., Hirt, Breslau, 1925–1931; 4th vol. forthcoming), Hermann Lautensach's "Laenderkunde: Ein Handbuch zum Stieler" (Justus Perthes, Gotha, 1926), and "Das Erdbild der Gegenwart," edited by Walter Gerbing (2 vols., List & von Bressensdorf, Leipzig, 1926–1927).

Eckert concludes his first volume with an exposition of the "science of landscape zones" (*Landschaftsgürtellehre*), or "comparative landscape study" (*vergleichende Landschaftskunde*), based mainly on Passarge (see, for example, Siegfried Passarge: Vergleichende Landschaftskunde, 5 parts, Reimer, Berlin, 1921–1930). Philippson, on the other hand, subjects some of Passarge's basic concepts to searching criticism and concludes (Vol. 2, Part 2, p. 457) that "a general classification of landscape types is not possible" owing to the immense number of variables that have to be taken into consideration.

"Vergleichende Länderkunde" (comparative regional geography) is the title of an

important new book by Professor Alfred Hettner, who holds that there is no proper distinction between regional and general geography (see *Geogr. Rev.*, Vol. 20, 1930, pp. 354–356). The first volume (Teubner, Leipzig and Berlin, 1933) deals with general principles of physical geography.

Professor Kurt Hassert's "Allgemeine Verkehrsgeographie," which first appeared in 1913, was republished in a two-volume second edition in 1931 (Walter de Gruyter, Berlin and Leipzig). The entire work has been thoroughly revised and new chapters added on aviation and wireless communications. *Verkehrsgeographie* is the study of transportation and communications in their geographical relationships. The first part of Hassert's book presents certain general considerations concerning questions of distance, methods, etc. and includes a long and illuminating discussion of isochronic maps. This is followed by comprehensive sections devoted to land, sea, and air transportation and to mediums and means of communication (commercial languages, post, telegraph, etc.). The book is avowedly descriptive. The author holds, in view of the youth of *Verkehrsgeographie* as a branch of geography, that the concrete formulation, collection, ordering, and limiting of facts are of greater value than theoretical explanations or inadequately founded causal speculations. This point of view, which is also shared to some degree by Passarge, represents a departure from the more usual position taken by modern geographers, to whom the *explanatory* approach offers the only sure road to salvation.

In the field of regional geography three important series deserve mention. The "Handbuch der geographischen Wissenschaft" has been appearing since 1930 under the editorship of Fritz Klute (Akad. Verlagsgesell. Athenaion, Wildpark-Potsdam). Some forty contributors are participating. The aim is to render geography interesting to the general reader, and with this end in view the volumes are being lavishly illustrated with maps, photographs, and colored views (see *Geogr. Rev.*, Vol. 24, 1934, pp. 159–161). "Allgemeine Länderkunde," a series of regional geographies founded by Wilhelm Sievers over forty years ago and published by the Bibliographisches Institut, Leipzig, is the German counterpart of the magnificent French "Géographie Universelle." The original six volumes have all been reissued in two or more later editions with extensive revisions and changes that have made them essentially new works. Three recent volumes are the third edition of Sievers' "Afrika" by Fritz Jaeger, 1928; Alfred Philippson's "Europa ausser Deutschland," 1928; and Otto Maull's "Deutschland," 1933. The greater part of the last named consists of detailed descriptions of more than one hundred geographical regions and subregions of Germany. "Allgemeine Länderkunde" is intended for general readers as well as for professional geographers. The series "Allgemeine Länderkunde der Erdteile" (Hahnsche Buchhandlung, Hanover), on the other hand, is designed primarily for professional use and will consist of seven volumes, each covering the general geography of a continent. The series is conceived as a continuation of Hermann Wagner's standard "Lehrbuch der Geographie" and reflects Wagner's scholarly and critical spirit. Up to date two volumes have appeared, one by Fritz Machatschek on North America (1928) and the other by Walter Geisler on Australia and Oceania (1931). These should not be confused with the volumes in the Sievers series by the same authors and dealing with the same regions.

On January 1, 1933, appeared the first number of *Geographische Wochenschrift*, edited by Dr. Irmfried Siedentop. Each number contains several short articles together with substantial book reviews and surveys of current periodical literature, maps, and events of geographical importance. While no phase of geography is neglected, interest appears to be centered on pedagogical and methodological topics and on political geography. It may be regarded as a sign of the times that several articles in this and in recent numbers of other German geographical periodicals are on *Wehrgeographie* (geography of defense) and that a docentship in this subject was established in 1933 for the first time in a German university (Berlin). Among

contributors to *Geographische Wochenschrift* may be counted such well known geographers as Maull, Passarge, Hassert, Scheu, and Banse. An admirable feature is the extremely detailed systematic index of the first volume (1933).

OBITUARY

Dr. Marion I. Newbigin. By the death of Dr. Marion Isabel Newbigin in Edinburgh on July 20 Britain loses one of her leading geographers. Dr. Newbigin had a philosophy of geography and put it into effect. One recalls her trenchant address as president of the geographical section of the British Association in 1922: "The time seems to me to have come for a determined missionary effort, a deliberate attempt to make clear to the ordinary citizen that geography, in its modern aspects, is a subject of direct interest and value to him in his daily life." Dr. Newbigin came to geography by way of the biological sciences, and she stressed the value of biological principles applied to human geography—"human geography is the biology of man"—with the difference that "man's vast power of modifying his environment, necessitates a fuller knowledge of that environment." A good illustration of these applications is afforded in her paper "The Origin and Maintenance of Diversity in Man" contributed to the *Geographical Review* (November, 1918).

The great range of Dr. Newbigin's writings, marked as they are by broad knowledge and good judgment, demonstrates her grasp of the complexities of the subject. Much of her work was directly educational. She long acted as examiner in geography for various institutions (cf. "The Training of the Geographer: Actual and Ideal," *Scottish Geogr. Mag.*, Vol. 41, 1925, pp. 27–36). Many of her books are textbooks but with an interest transcending the usual limits of the category. She could also write for the general reader, and, as one reviewer said, she "uses scientific facts daringly and without pedantry." Her little volume "Modern Geography" (1911) in the Home University Library series is a model of succinct presentation. She traveled extensively. In "Frequented Ways" (1922) she expresses the hope that "something of the joy of intensive travel shines through the pages." Her most valued contributions probably were those relating to the Mediterranean, including "Geographical Aspects of Balkan Problems" (1915), "The Mediterranean Lands" (1924), and "Southern Europe" (1932). But she will perhaps be remembered most of all for her editorship of the *Scottish Geographical Magazine* for a period of thirty-two years.

Sir T. W. Edgeworth David. The Grand Old Man of Australian science has passed away after more than fifty years devoted to research in the southern hemisphere. Sir T. W. Edgeworth David was born in 1858 near Cardiff in Wales. In 1882 he joined the Geological Survey of New South Wales, geology already chosen as his life work. His first outstanding research was the survey of the Maitland coalfield (west of Newcastle) in 1886. Here he discovered perhaps the greatest coalfield in the southern hemisphere, one that is now the chief producer in Australia. A large volume dealing with the area, profusely illustrated with maps and sections, appeared in 1907. In May, 1891, he was appointed Professor of Geology and Physical Geography at the University of Sydney and began that career that has left so great a mark on the lives of many young Australian scientists. His second outstanding contribution to science resulted from an expedition that he led in 1897 to the remote island of Funafuti. Here a bore was put down to a depth of 1114 feet to test the character of the foundations of a typical atoll. The continuity of the coral rock supported Darwin's theory of the evolution of atolls.

A third field of his research was connected with the remarkable "fossil Ice Ages" well represented in Australia. In 1906 he visited the Deccan and Mexico in connection with this investigation. Probably he is best known outside Australia for his

Antarctic explorations. In 1907 he accepted Shackleton's invitation to visit Antarctica and observe an "Ice Age in being." He found the region so fascinating that he remained south throughout the expedition's stay instead of returning with the ship. In the first summer he led the party that climbed the ice-covered volcano of Erebus (13,200 feet). His chief exploit, however, was the attainment of the South Magnetic Pole on January 6, 1909. Too little credit has been given David and his party for their perilous march with man-hauled sledges along 200 miles of breaking sea ice on the coast of Victoria Land. Everyone interested in polar science is familiar with the huge memoir, written in collaboration with R. E. Priestley, which deals with the glaciology and tectonic geology of South Victoria Land.

When war broke out David aided energetically in recruiting a mining corps and accompanied it to the front. In France he became chief geologist to the British armies, and in the course of his service he received a severe wound, from whose after-effects he was never wholly free. At the close of the war he was awarded the D.S.O., and the order of knighthood (K.B.E.) was conferred upon him in 1920. He was also the recipient of many scientific honors. He retired from the University of Sydney as professor emeritus in 1924. The last ten years of his life were devoted to his textbook of Australian geology, of which the very valuable large-scale map with explanatory notes has already been published (compare *Geogr. Rev.*, Vol. 23, 1933, pp. 163–164).

It is as a teacher, lecturer, and, one may say, orator that his innumerable friends will perhaps best remember him. When deeply interested in his lecture his voice would ring out like a clarion, awakening enthusiasm in all types of audience. He was on every important scientific committee and was ever willing to give his too crowded time to aid any attempt to improve the status of science in Australia. His students loved him for his camaraderie, for his old hat and his still older umbrella, for his courtesy and aid given equally to nervous freshman or senior colleague. Those of us who were privileged to work closely with him owe him our worldly advancement as well as an abiding and a many-sided love of science. To many of the younger generation he seemed a modern Bayard, *le chevalier sans peur et sans reproche.*

GRIFFITH TAYLOR

GEOGRAPHICAL REVIEWS

A French National Atlas

Atlas de France. Four instalments, 16 sheets: Pls. 3–6, Relief du sol; Pls. 12–13, Températures; Pl. 44, Richesses minérales concessibles; Pl. 45, Carrières principales; Pl. 48, Travail des métaux industriels; Pl. 49, Industries textiles; Pl. 61, Télécommunications; Pls. 72–75, Densité de la population en 1931; Pl. 77, Mouvement de la population. Comité National de Géographie, Paris, 1933–1934. Sheets 20 x 25 inches.

The present 16 sheets are the first four instalments of a French national atlas that began publication early in 1933 and that is to be completed with a total of 80 sheets expected to be published in five years. The atlas is being prepared by the Comité National de Géographie, which was founded in 1920 under the sponsorship of the Academy of Sciences and may be likened to the geographical section of the Division of Geology and Geography of our National Research Council. The sheets already available show that this atlas is destined to occupy front rank among the valuable national atlases portraying the various aspects of the geography and economics of a given country, of which the Atlas of Finland remains the outstanding example and of which Poland, Norway, the U.S.S.R., and Canada each have their counterpart. The present era of national planning makes the need of such an atlas of the United States particularly evident.

The atlas is intended to portray all aspects of the geography and national life of France that are amenable to cartographic synthesis. The topics are grouped under four principal headings, two of which each have three subdivisions, as follows: (1) physical geography: (a) topography and physiography, 11 sheets, (b) climatology, 8 sheets, (c) hydrography, 6 sheets; (2) biogeography, 6 sheets; (3) economic geography: (a) agriculture, 9 sheets, (b) industry and manufacturing, 11 sheets, (c) commerce, 11 sheets; (4) human and political geography, 16 sheets. The arrangement of the maps on a sheet follows six set patterns in which six different scales are used. The largest scale, 1 : 1,250,000, is employed for the representation of a quarter of France on a sheet; the next, 1 : 2,500,000, for the whole of France on one sheet. Two type patterns carry a number of small maps on one sheet, six in 1 : 6,000,000 in one case and twelve in 1 : 8,000,000 in the other. In the case of the remaining two, one or two larger maps in 1 : 4,000,000 are accompanied by a suitable number of smaller maps in 1 : 8,000,000 to fill the sheet. This scheme permits the portrayal of all relevant phenomena on scales that are readily comparable.

Four overlapping sheets in 1 : 1,250,000 provide an admirably balanced picture of the relief of France. The interrelation of lowlands, uplands, and mountains of moderate and of great altitude is set forth with just the right emphasis. This is due to the critical selection of the contours and altitude tints used and of the names shown. When the contour interval selected would fail to bring out a characteristic topographical feature, a contour is intercalated within a given tint, as in the case of the cuestas between Nancy and the Plateau of Langres. The addition of a dark-brown tint for the 2500 to 3000-meter layer since the edition of the southwestern sheet published as one of three preliminary sheets on the occasion of the International Geographical Congress at Paris in 1931 (see *Geogr. Rev.*, Vol. 22, 1932, p. 138) has given character and life to the portrayal of the Pyrenees and the Alps. Names are restricted to names of physical features, among which physically conditioned regions and *pays* predominate, and to a limited number of towns for locational purposes (in passing it may be noted that the symbols for Lyons and Marseilles do not represent these cities in their true ground plan, as the explanatory note on the backs of the sheets states they do). The map deserves to take its place beside the similar map of Britain, 1 : 1,700,000, with a systematic nomenclature of the orographical features

(accompanying H. R. Mill: England and Wales Viewed Geographically, *Geogr. Journ.*, Vol. 24, 1904, pp. 621–636), as the standard generalized representation of the relief of France for research purposes.

One of the two climatic sheets has especially valuable maps of actual temperatures in January and July and for the year as well as insets showing length of frost period and progressive dates of leafing of the oak as an index to the beginning of spring and of the harvesting of winter wheat as indication of the beginning of autumn. Mineral resources are depicted on one sheet in 1 : 2,500,000 and rock-derived products on six maps in 1 : 6,000,000 on another sheet. The latter and the metallurgical and textile maps indicate distribution of production by means of symbols of different size and color. The sheet devoted to long-distance communications shows on several maps the location of trunk telephone lines, number of subscribers and booths in the cities, telephone density by *départements*, location of wireless commercial and weather stations and of radio broadcasting and radio telephone stations, and the telegraphic network.

The sheets dealing with population are among the most interesting. In addition to a sheet of small maps in 1 : 8,000,000 showing increase and decrease of population, birth and death rates by departments and periods, there is here available, in four sheets, a complete picture of the population density of France according to the census of 1931. Three shades of blue at the lower end of the scale and four of mauve-brown and pink at the upper end diminish toward an intermediate density in yellow. The data were plotted by communes (about 38,000 in the 213,000 square miles of France), and densities are shown by these administrative units, although boundaries of contiguous communes of the same density grade (and hence color) are omitted. Owing to the small size of the commune as a statistical unit the map of course yields a very intimate picture, and the urban and industrial centers are especially well brought out because of their dark-brown color. But the resulting mosaic pattern presents a rather restless appearance. While it is recognized that population density is not a phenomenon of consecutive uninterrupted gradation, such as slope in topography or gradient in climatology necessarily is, it would be interesting to know what has led the two geographer authors of this map to decide upon the statistician's method of the cartogram rather than the geographer's method of isopleths or other reality-approximating principle involving *generalization*. Curiously enough, a leading French statistician and political economist, when confronted with the same problem forty-five years ago, chose the isopleth method (see Émile Levasseur: La démographie française comparée, *Bull. Inst. Internatl. de Statistique*, Vol. 3, No. 2, 1888, pp. 1–103, with map in 1 : 1,600,000 by Victor Turquan using isopleths based on figures for communes; also in Levasseur's "La population française," Vol. 1, Paris, 1889). Neither the isopleth nor the abrupt color transition between administrative units of discontinuous densities does full justice to the phenomenon of population distribution, and professional discussion of questions of technique is still a fruitful theme. The junior author of the present map had himself, in an earlier day, pleaded the cause of population-density representation by natural areas and brilliantly illustrated it with the example of Wallachia in Rumania (map in 1 : 1,200,000 based on 1899 census in Emmanuel de Martonne: Recherches sur la distribution géographique de la population de la Valachie, avec une étude critique sur les procédés de représentation de la répartition de la population, *Bul. Soc. Geogr. Romînă*, Vol. 23, No. 2, 1902). Latterly a related method of grouping population by belts and scattered areas of homogeneous densities, and hence generally nonsequential contiguity, has been applied with revealing results on the so-called "dasymetric" maps of European Russia in 1 : 420,000, begun in 1922 (see *Geogr. Rev.*, Vol. 16, 1926, pp. 341–343), and on the population map of Great Britain in 1 : 1,000,000 according to the census of 1931 published in 1933–1934 by the Ordnance Survey, which, in method, carries forward the principle already utilized by F. Bosse on his two density maps, 1 : 1,300,-

000 and 1 : 1,700,000 respectively, in Bartholomew's Survey Atlases of Scotland, 1895 (2nd edit., 1912), and of England and Wales (for comment see *Geogr. Journ.*, Vol. 8, 1896, p. 520, and H. R. Mill, presidential address, Section E, in *British Assn. for the Advancement of Sci., Rept. 71st Meeting, Glasgow, 1901*, London, 1901, pp. 710–711, and *Scottish Geogr. Mag.*, Vol. 17, 1901, p. 521). The examples of the Russian and Ordnance Survey maps provide valuable evidence of the validity of the method in demonstrating its feasibility and value in the case of maps on both relatively large and relatively small scales.

The Territory of the Saar

Hermann Overbeck and Georg Wilhelm Sante, edits. **Saar-Atlas.** 104 pp., 10 plates of photographs, 40 plates of maps. Justus Perthes, Gotha, 1934. RM. 8. 15½ x 9 inches.

R. Reinhard and K. Voppel. **Land und Volk an der Saar.** 176 pp.; maps, diagrs., ills. (Museum für Länderkunde zu Leipzig.) Ferdinand Hirt, Breslau, 1934. RM. 1. 7½ x 5 inches.

Work produced under a pending political plebiscite is likely to be dominated by propaganda. Happily the "Saar-Atlas" maintains a high scientific standard and is indeed an excellent example of what can be done in the way of a regional atlas. It provides a detailed picture of the human geography of the area, historical, economic, social, and political—a mine of information presented in the most accessible form for any social scientist studying the area.

Economically the importance of the Saar area lies in its coal mines and in its iron and other industries. In coal and in iron and steel production it is about equal to the Birmingham, Ala., district. Its annual coal production of 13 million tons represents about nine per cent of that of Germany today or about one per cent of the world's total. The iron industry produces some two million tons of pig iron and the same amount of steel—about one-seventh of Germany's production, two per cent of the world's total. These figures, however, both of coal and of iron, represent from one-fifth to one-fourth of the present production of France. In certain other industries, actually much less important, such as the pottery and glass industry, the Saar area is relatively more important. The proportional importance of the different industries within the Saar is shown in the following table.

Basic Industry	Population	
	Per cent directly supported	*Number estimated dependent*
Agriculture	8⅓	100,000
Coal mining	27⅓	325,000
Iron and associated industries	17	200,000
Other manufacturing	14	165,000

The relative unimportance of the area except for its mines and industries is clear; furthermore, without these as markets the agricultural population of the region, rough, hilly, in many parts of infertile soil, would be far less than 100,000. Coal mining is, of course, all-important, not only because it accounts directly for the largest population group but because of the dependence on it of the manufacturing groups, few of which could survive in this otherwise handicapped area.

In this respect, as in several others, the area is notably similar to that other district

of political concern, Upper Silesia (cf. Richard Hartshorne: The Upper Silesian Industrial District, *Geogr. Rev.*, Vol. 24, 1934, pp. 423–438). In each case a rich resource—coal—is exploited with difficulty because of the handicaps of a location relatively far from the sea and yet on the periphery of markets politically determined. The same factors limit the development of manufacturing, so that but little more than a third of the coal production is used locally. While proximity to the minette iron-ore district of Lorraine has enabled the iron industry here to develop to a greater extent than that in Upper Silesia, similar unsuitability of the Saar coal for metallurgical coke has prevented the much larger development that might otherwise be expected.

The mines and industries that dominate the life of the Saar area are highly concentrated in a crescent-shaped district, open on the north, located on the southern margin of the area and close to the Lorraine frontier (see map sheets 24 and 34: references throughout are to map-sheet numbers). The east wing of the crescent follows the narrow belt of the coalfield that extends on the south a short distance into Lorraine; the west wing follows down the Saar Valley for some distance below the crossing of the coalfield (23 and 26). This crossing is marked by the greatest concentration, a narrow ribbon of urban and industrial land threading the narrow valleys (3, 17, and 18), in the middle of which is Saarbrücken, the one important commercial center of the area, a city of 130,000 population, or larger if the commuting population from adjacent towns and villages is included (37).

While most of the maps in the atlas present primarily the internal geography of the area, they are used, in some cases with a certain exaggeration, to show a closer connection with Germany than with France. The language map indicates that the Saar is not a border area of mixed population but rather lies well within the German-speaking area, the boundary running some eighteen miles farther west through Lorraine (1). The Prussian census of 1910 showed only 339 citizens as French-speaking, or one-twentieth of one per cent. This is in keeping with the historical association. France ruled here only 42 years, against a thousand years of German rule—under Louis XIV from 1680–1697 and again under Napoleon from 1790–1815 (7). During the century between those short periods France did maintain a few fortress enclaves, such as Saarlouis, controlling a small part of the area.

Church history likewise reflects the association, through the bishopric of Trier, of most of the area with other German regions, in contrast with Lorraine under that of Metz (10). Very interesting maps and diagrams of house and village forms, church architecture, place names, and folk customs indicate on the whole the association of the Saar with the area of German culture rather than that of France (12–20). The same association is reflected in the agricultural maps (21 and 22). The preference for rye instead of wheat and the importance of potatoes are only partly explained by soil conditions; they represent a well known cultural difference along the Franco-German divide.

Coal mining and heavy manufacturing are, of course, essentially unaffected by minor cultural differences. Of chief importance are their connections with outside areas. For the coal industry that means markets (38 and 39). The market areas for Saar coal appear to have been determined chiefly by political or politico-economic (tariff) factors. Perhaps the fact that they were, with one exception, owned by the Prussian state—now by that of France—accentuates this connection.

Although the iron industry of the Saar is primarily dependent on the coal production, its development in this area, as in Upper Silesia and in the Pittsburgh and other fields, antedates the use of coal for smelting (28 and 29). Many small bodies of *Toneisenstein* furnished the raw material for small charcoal furnaces established in some cases as early as 1800. The second oldest (Dillingen) of the five iron furnace companies still active in the area was started by French interests in the first period of French control (1685), but to attach importance to this fact, as various French

writers have, is to exaggerate: at the close of the second period of French control in 1815 the total number of workers in all the iron plants of the area was less than five hundred, or about one per cent of the present figure. The development of this industry has been within the last century of industrial development and under German control.

With the exhaustion of local iron ores the industry has long since shifted to imported ores. While some ore was brought in from the Lahn Valley (on the other side of the Rhine), more than 95 per cent was received from the neighboring minette-ore field in Lorraine and Luxembourg (30 and 38). All the principal iron companies in the Saar had ore properties, chiefly in the former German Lorraine, but also in Luxembourg and even French Lorraine. For the most part these connections remain today, though on a different financial basis. In addition to importing all its ore, the Saar iron industry must also import some coal because of the friability of the coke produced from Saar coal alone. Most of this comes from the Ruhr, some from the Aachen field; in each of these are mines owned by Saar companies (30). This connection, however, is far less important than that with Lorraine.

The outside markets, upon which the Saar iron industry is almost entirely dependent, are most significant (38 and 39). Here the situation is somewhat similar to that in the coal industry, except that the change since the war is by no means so great; the shipments into Germany (chiefly the Upper Rhineland and South Germany) are still larger than those into France, including Lorraine, in spite of tariff difficulties. Likewise the by-products of the iron industries—cement and fertilizers—were shipped to Germany in 1925–1930 in greater amounts than to France. The same was true of glassware. Fire brick, however, is sold to such a large extent (one-third) to the Lorraine iron industry that the total sent into France is slightly larger than that shipped to Germany. The clay for this industry, however, comes almost entirely from Germany.

Although the mines and industries of the Saar are so closely concentrated, the workers employed live in practically all parts of the present political area and beyond in Germany (34–36). They are largely descendants of the original farming population and still live to a considerable extent in the villages of their forefathers. Formerly many of them—in 1875 more than a third—lived in rooms or dormitories near their work places during the week and went home only for week-ends; about one-twelfth still do. Aside from those who travel considerable distances by bicycle, large numbers commute by bus and rail. Detailed maps of the latter movement show important numbers of workers residing in Germany, crossing the present (northern and western) boundaries of the Saar area daily to work in seven of the thirteen industrial centers (37). Except for a few from the border town of Saargemünd, none cross the frontier from France (Lorraine). On the contrary there is some movement (not mapped) from the Saar into the mines in the Lorraine extension of the coalfield.

Like all parts of the Moselle highlands, the Saar area is somewhat cut off from neighboring areas. The maps do not appear to uphold the claim of the text that the "natural connections" of the area with the Rhineland are much stronger than those with Lorraine. Seven railroads connect the area with other German areas, six with Lorraine; to be sure, the number of trains crossing the frontiers daily indicates more connection with Germany: some 220 to 160 odd (32). The road map shows 17 main roads crossing the German frontier, 10 more than cross that of Lorraine (3). Of electric power lines, two connect with Lorraine, five or six with Germany (27).

Although the Saar is a tributary of the Moselle, navigation via that route has never been developed and would now certainly be out of the way. The sole water connection is via the Saar canal (33), and this is of minor importance, carrying less than a million tons of freight. Importance is attached to the plans for a Saar-Pfalz canal via the Kaiserslautern route to give direct connection with the Upper Rhine and the markets for Saar coal and iron in South Germany.

RICHARD HARTSHORNE

"Land und Volk an der Saar" is a good example of the work of the Museum of Regional Geography in Leipzig (see *Geogr. Rev.*, Vol. 24, 1934, pp. 219–231), making admirable use of graphic art in its maps, diagrams, and photographs. With a brief accompanying text these depict the physical setting of the region and its history, cultural and economic development, and political problems. Illustrations that may be singled out for special mention are: the cultural landscape of Friedrichsthal in 1818 and 1913 (p. 44; compare *Geogr. Rev., op. cit.*, p. 228); population distribution in the environs of Saarbrücken in 1850 and 1927 (pp. 46–47); industrial development of the Saarbrücken—Völklingen district between 1800 and 1930 (pp. 50–51); population density (pp. 56–57); diagram of land utilization in the Saar region compared with utilization in Germany and France (p. 92; compare above review of the "Saar-Atlas"); distribution of working places and dwelling places of the miners (pp. 104–105); cartogram of the destination of Saar coal in 1913 and 1928 (pp. 118–119). The photographs are beautifully reproduced; many of them might well serve as type pictures—for instance those of the *reihendorf* and *haufendorf* settlements on pages 68 and 69 respectively. The small format scarcely does justice to the illustrations, but the price of the little book has been kept extremely low.

A French Series of Human Geographies

Jules Blache. **L'Homme et la Montagne.** 190 pp.; ills. (Géographie Humaine, 3.) Librairie Gallimard, Paris, 1933. 30 fr. 9 x 5½ inches.
Pierre Deffontaines. **L'Homme et la Forêt.** 188 pp.; ills. (*Ibid.*, 2.) 1933.
Georges Hardy. **Géographie et Colonisation.** 209 pp.; ills. (*Ibid.*, 1.) 1933.

The study of mountains is as complicated and, by its complications, as absorbing as any of the phases of geography. European geographers know their mountains in detail and have produced an amazing list of books and articles on problems in minutia or on the larger aspects of regional geography. Hitherto there has been almost nothing published that may be read as a summary. Now we have Jules Blache's "L'Homme et la Montagne." Blache finds most of the mountains significantly inhabited to lie between latitudes 30° and 50° N. and within a stretch of 120 degrees of longitude. Quite rightly most of the book is an interpretation of the relations of man to mountains in terms of the significance of alp pastures in the local economies. The book is charmingly written and though highly informational is a summary in nontechnical writing for the lay reader. French, German, and Italian writings on mountains have been so academic and detailed as to make more often than not poor reading for anybody but the highly trained. They seldom indicate the quality of life. Such is Blache's great work "Les Massifs de la Grande-Chartreuse et du Vercors." This more recent and general book on man and mountain catches, however, the spirit of mountain life. Logically the book spends most of its pages on the Alps, but Asia, Africa, and even North America come in for their share of treatment. Not the least of the attractions are the forty sepia prints well chosen as illustrations and as works of art. Roderick Peattie

"L'Homme et la Montagne" has for its predecessors in the series Georges Hardy's "Géographie et Colonisation" and Pierre Deffontaines' "L'Homme et la Forêt." They are similarly successful in conveying the spirit of the theme pursued and are of the essence of human geography. As a preface to the series Professor Deffontaines, who is directing the enterprise, has written a short essay on "What is Human Geography?" It is quotable in its entirety, but we must here content ourselves with reference to an anticipated criticism that some of the projected volumes of the series may be found too daring or premature in their appearance. "Mais c'est précisément là, croyons-nous, un caractère qui fera leur utilité. Toute étude n'a-t-elle pas pour but principal d'être un élément d'éveil. Or, la géographie humaine, jeune science, a

encore bien peu pénétré dans le public curieux et instruit, elle est restée, avec un certain égoïsme, réservée à ses seuls spécialistes; sans doute, elle a donné déjà largement maints récits de voyages et d'explorations qui souvent ont eu de gros succès prouvant l'intérêt du public par les faits géographiques, mais ces récits ont été bien plus informateurs que formateurs. La géographie humaine peut aujourd'hui apporter davantage: ouvrir de nouveaux horizons de curiosités, permettre au voyageur, au vrai touriste, à celui qui fait un tour, d'élargir le champ de ses investigations et la gamme des questions que posent les pays. Elle réclame en outre un souci du concret, du réel qui empêche les abstractions et les généralisations dangereuses et hâtives et, par là, elle fournit comme une salubrité scientifique qu'elle a le devoir de répandre."

Problems of Agricultural Geography

Leo Waibel. **Probleme der Landwirtschaftsgeographie.** 94 pp.; map, diagrs. (Wirtschaftsgeogr. Abhandl., No. 1.) Ferdinand Hirt, Breslau, 1933. 10 x 7 inches.

Professor Waibel begins his "Problems of Economic Geography" with a discussion of those factors which make up, or should make up, the discipline of agricultural geography, such as the nature of the soil, plants, climate, people and their state of culture, domestic animals, etc. He points out, however, that observations in the field mean little to a geographer unless he has been well trained in theory first.

In the second chapter, after an exhaustive consideration of the definitions of a plantation, the author gives his own: "A plantation is a big industrial-agricultural business, which, as a rule, under the supervision of Europeans produces, with great expense of capital and labor, valuable vegetable products for the market." A section on the history of the plantation ends thus: "All parts of the earth contributed to the classic form of the plantation in the tropics of the New World: Europe furnished the capital, Asia the economically valuable plants, Africa the workers, and America the climate and soil."

Especially interesting is the chapter on the South African Boers. Their history, economy, and habits of life and thought are taken up in detail. The conclusion reached is that "from a seafaring people, whose motherland is half under water, and criss-crossed with streams, has been developed the Boer herdsman who in all ways has adapted himself to the desert character of the African veld. . . . From the industrious, cleanly Dutchman evolved the lazy, dirty Boer; the thrifty farmer became a simple herdsman; the rich, professionally highly specialized commercial folk became a poor, homogeneous stock-raising people." It is pointed out that from the coast as one goes inland the intensity of commerce and culture decreases, and the "rings" and forms of life postulated in the "isolated state" by Thunen are—where the folk is homogeneous—present.

Chapter IV is dedicated to Thunen's law and its meaning for agricultural geography. Six "rings" are distinguished around the center of Thunen's postulated "isolated state." The first ring is dedicated to gardens and truck patches. Then follows the forest, or the lumber-producing ring. In the third ring will be grown bulky, easily stored cereal and forage crops. The fourth ring will be successively ploughed, planted, and pastured, whereas the fifth is given over to the three-field system of cultivation, one field lying fallow each year. The sixth ring is given over entirely to pasturing. A history of this theory and of attempts to apply it in reality is given by Professor Waibel, with the conclusion that the "isolated-state" idea enables us to distinguish between "the natural and artificial forces which have gone toward producing the present agricultural-geographic organization of the earth."

The most interesting chapter in many respects is the last one, dealing with the problem of supplying the temperate zone with agricultural products of the tropics. The author shows how the United States—"with almost rudimentary force"—is

assuring itself of a continual supply of tropical raw products in the Caribbean region, as she becomes more highly industrialized. Japan has no less emphatically shown that the Asiatic tropics are her "natural" market for manufactured goods and source of raw materials. The conclusion is that Europe must in future pay more attention to her "natural" tropical region, the African, which, though it represents 43 per cent of the area of the tropics of the world and 15 per cent of the population, enjoys only 9 per cent of the world commerce in the tropics. And here he claims that an overpopulated industrial country like Germany "has as much right to a 'place in the sun.' as have England, Belgium, the United States, and Japan."

Professor Waibel is one of the ablest young European geographers. His work in German East Africa before and during the war, his travels in Mexico (Die Sierra Madre de Chiapas, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 43, 1933, pp. 12–162) and the United States, and his years at Kiel and Bonn as professor make him especially qualified to direct the publication of "Essays on Economic Geography" and to contribute the first number. In this short book we are introduced to many pertinent questions. The style is especially to be praised. The author uses a very pure, simple German, easy to understand. He has a delightful sense of humor, and his book is not encumbered with needless detail.

RAYMOND E. CRIST

THE ECONOMIC SIGNIFICANCE OF BARCELONA

JULIUS O. REICHENHEIM. **Die wirtschaftliche Bedeutung von Barcelona.** 71 pp.; maps, bibliogr. *Veröffentl. Inst. für Meereskunde*, N.S., B. Historisch-volkswirtschaftliche Reihe, No. 8, Berlin, 1933.

In Spain "Catalan" connotes industry, industrialism, and energy. In arid interior Castile there is no power and only hand industry. Men of necessity grow wheat, an occupation involving long periods of idleness—in strong contrast with conditions in Catalonia, where Pyrenean water power keeps work going summer and winter, even night and day. Long before the days of steam or electricity Catalan industry was established and important. Reichenheim declines to enter into the "Catalan question," which sees special endowments in this group of the Spanish people, but the physical environment is offered as having at least some hand in shaping the dwellers east of the Ebro Catalan.

Of old Aragon's lot had been cast with Catalonia. Those were flourishing days in Barcelona when fleets built with lumber from the Pyrenees and Catalan iron traversed the Mediterranean and brought to Spain the wealth of India. Then came Columbus and Ferdinand and Isabella. The wedding of Aragon and Castile in their persons meant the divorce of Aragon from Catalonia. The Turks closed the Mediterranean on the east, Columbus reached "India" in the west, and Isabella, decreeing death to any inhabitant of Aragon or Catalonia who traded in the West Indies, dealt a mortal blow to Barcelona and founded the undying hatred of Catalans for Castile.

Since 1492 the commerce of Barcelona has been moderate and limited. Even its industry is limited to producing for the Spanish market. Though Catalans find it hard to believe, the Madrid government has fostered that trade and made it possible. Catalonia is active and modern in industry if compared with Spain rather than with Europe. She cannot compete in the world's markets with countries using cheap coal. She is more heavily taxed than the Basque Provinces, which are also notable in Spanish industry. Her aspirations exceed reasonable expectations.

Good statistics are lacking, as for most things Spanish, but the really native industries are in small, often family, units. The larger, more modern, and more pretentious installations of the larger cities are largely foreign, with foreign capital and direction, imperfectly veiled in these days from the prohibitions of nationalistic laws.

MARK JEFFERSON

The Historical and Cultural Development of China

KENNETH SCOTT LATOURETTE. **The Chinese: Their History and Culture.** Vol. 1, xiv and 506 pp.; Vol. 2, 389 pp.; map, bibliogrs., index. The Macmillan Co., New York, 1934. $7.50. 8½ x 6 inches.

Dr. Latourette's latest book will place under deep obligation all who are interested in the historical and cultural development of China. Written in a clear and readable style, it displays accuracy, fairness, and a fine sense of proportion. The author makes use not only of the older literary materials but also of the results of recent investigation in a wide range of fields. On many points regarding which full agreement has not yet been reached he suspends judgment, erring in this respect, if at all, on the side of conservatism.

In dealing with a book of such comprehensive scope we must limit ourselves to discussion of a few representative parts. Thus the author commences with an excellent description of the geographical environment, noting how this has influenced, although it has not determined, the form assumed by Chinese civilization. In this connection he institutes an interesting comparison between China and India.

The treatment of the prehistoric period leaves little to be desired. It needs qualification, however, on one or two points. Thus it now seems clear that China remained in a purely neolithic state of barbarism until at least around 2000 B.C., instead of 3000 B.C. as the author suggests. Again, it was almost certainly in the first half of the second millennium before our era and not during the third millennium that anything like a true civilization appeared there, in the guise of an already well developed Bronze Age culture complex. The latter in turn long remained the exclusive and jealously guarded prerogative of a very small ruling class. It was not until iron came into general use, late in the first millennium before Christ, that the Chinese people as a whole entered upon the Age of Metals.

As the author states, the historical civilization of China can no longer be regarded as wholly unrelated to that of the rest of the ancient world. It is coming to be recognized for what it really was—a backward and slightly aberrant member of a group of kindred civilizations that arose in late prehistoric times throughout the north temperate zone of the eastern hemisphere. These civilizations, as Dr. Berthold Laufer pointed out a score of years ago, had certain basic traits in common, among them the use of the plow and cart, the possession of the same domestic animals and food plants, and the employment first of bronze and then of iron as the principal metals. It is only by keeping this fundamental fact steadily in view that we can hope to understand rightly China's true place in the history of human progress.

Dr. Latourette's account of the archaic culture of the Shang and Chou dynasties (*ca.* 1550–250 B.C.) is excellent. He also presents a vivid picture of the collapse of the ancient feudal régime and the founding on its ruins by a man of genius, late in the third century before Christ, of a centralized and bureaucratic empire. This governmental system, the author points out, has been one of the most stable and effective ever devised by man. It persisted, with but little modification save in detail, for more than two thousand years (221 B.C.–1911 A.D.), and it succeeded in molding into a fairly homogeneous whole a very large fraction of the entire human race. Dr. Latourette scores a good point in this connection when he says that the Chinese people are culturally but not nationally self-conscious. To this might be appended the statement that the outlook of the overwhelming majority and particularly of the peasantry is almost incredibly parochial.

But while the form of government survived thus long, the character of the civilization itself was steadily undergoing modification. As the author tells us: "Chinese cultural history is by no means a dull repetition of a few themes, as was so much of political history between the Han and the end of the Ch'ing. However, there was no break so marked as that which occurred between the Persian and the Post-

Alexandrian Hellenistic periods in Western Asia, or as that between the Roman Empire and Medieval Europe. No cultural or political invasion from without had so nearly overwhelmed the native inheritance as had several of those which the Occident had known."

Dr. Latourette is especially at home on the subject of religions in China. His account of the history of Buddhism in that country is one of the best that has appeared. His account of the introduction of Nestorian Christianity into China in the seventh century, in the great days of the T'ang dynasty, is likewise interesting and authoritative. Coming down to more recent times, he discusses fully and impartially the effect upon Chinese life of European and American missionary enterprise. His description of the manifold ways in which the esthetic spirit of the Chinese has found expression is at once lucid, critical, and appreciative. The chapter on the art of China will perhaps find a wider appeal than almost any other in the book.

The author analyzes the various causes that led to the downfall of the ancient governmental system, less than a generation ago, and brought on the present state of political and social collapse. As he shows, the existing situation has by no means been due solely to the shattering impact of Occidental civilization. Internal causes were also at work.

His prognostication is not precisely cheerful as far as the near future is concerned, but he ends on the following note of qualified optimism: "The next century or more probably has in store as intense sufferings as the Chinese have ever known. Some of us, however, are not without faith that these will prove the birth pangs of a new and greater China—even though we cannot now clearly discern its features."

In a work as comprehensive as this slips are bound to occur. A few of these are perhaps worth noting. Such are the statements (Vol. 1, p. 41) that during the Shang period—roughly the latter half of the second millennium before Christ—use was made in war of cavalry and of elephants and that the latter were even brought under domestication. The elephant is indeed known to have been *tamed* in China during the period named; but neither there nor anywhere else has it ever been *domesticated*. And mounted troops did not come into use in China until more than half a millennium after the Shang dynasty had ceased to exist. The assertion (Vol. 2, p. 76) that tea was already in use as a beverage in the Chou dynasty (*ca.* 1050–250 B.C.) appears not to find confirmation in contemporary documents. The statement (Vol. 2, p. 96) that coal was utilized in smelting iron as far back as the T'ang dynasty (618–906 A.D.) needs amending; for according to a leading Chinese geologist it was already being employed for that purpose nearly a millennium earlier.

To Dr. Latourette are due hearty congratulations upon "The Chinese: Their History and Culture." It is a splendid piece of work and one that it is a pleasure to commend to all classes of readers.

C. W. Bishop

Contribution to the Cartography of High Asia

Wilhelm Filchner. **Kartenwerk der erdmagnetischen Forschungsexpedition nach Zentral-Asien 1926–28.** Part 1: **China und Tibet,** I. 255 pp.; maps, diagrs., bibliogrs., index. *Petermanns Mitt. Ergänzungsheft No. 215*, 1933.

The establishment of an extended net of stations for observations on terrestrial magnetism took Dr. Filchner in 1926 on a journey through Russian and Chinese Turkestan, Kansu, Tibet, and northern India. His journey was remarkably well planned, for it covered a vast area unknown from the geophysical point of view. Ill equipped with funds, with meager additional support, hampered by the hostile attitude of Chinese and Tibetan officials, he was eventually placed under arrest in Tibet and barely escaped in the severe Tibetan winter weather. Such was the

adventurous background of his exploration, for which one would have wished him a more peaceful atmosphere.

This first part of his results is concerned with a description of four large maps on a scale of 1 : 500,000. They cover the regions of Koko Nor, the Tsaidam basin, Marco Polo Mountains, upper Yangtze Kiang, and the Tang La Range to a point some 160 miles north of Lhasa. The maps are partly based on his own surveys, which were carried out on a much larger scale (1 : 50,000 and 1 : 100,000), and partly compiled from previous sources. Owing to the small scale on which his topographic work is presented, much valuable physiographic information is lost. The multicolored maps picture this country as one of mountainous upland with extensive grazing grounds. Here is the homeland of Mongoloid, mainly Tibetan, nomads of ancient fame. Orographically the Tang La Range appears as a dominating axis, and its height (6500 meters) should therefore be corrected on maps and atlases. As elsewhere, the Tibetan relief shows as a blend of mature land forms and higher ranges, molded locally by glaciation and flattened by intense weathering at great altitudes. It is interesting to note that the tributaries of the Hwang Ho and Sining Ho are separated from the basin of Koko Nor by a relatively low divide. This makes the former existence of a longer, eastward-extended drainage system in northern Tibet highly probable.

The descriptive text, punctuated by sketches, makes easy reading. The lists of names in Tibetan, Mongolian, and Chinese characters are remarkable, a philological achievement of geographic value that deserves imitation, for it does away with the old-fashioned, one-sided translation of native names. This and the cartographic presentation make the work a valuable contribution to the geography of high Asia.

H. DE TERRA

AUSTRALIAN STUDIES

The Peopling of Australia (Further Studies). 327 pp.; maps, diagrs., index. (Pacific Relations Series, No. 4.) Melbourne University Press, Melbourne, in association with Oxford University Press, Melbourne, London, etc., 1933. 7½ x 5 inches.

The Australian section of the Institute of Pacific Relations is carrying out valuable work in publishing every year or two a volume of research by the members of the Institute. This book is the fourth in the series. The Introduction is by P. D. Phillips, who is a member of the faculty of the University of Melbourne, as are several of the authors of the ten chapters.

Although the book as a whole is sociological rather than geographical, each chapter has much of interest to the geographer concerned with problems of migration and development. Its chief value is the light it throws upon the necessity for a connection between politics, economics, and geography in problems of settlement. Too often the political authorities concerned know little of economics and nothing of geography, as the last chapter, on group settlement (by Gordon Taylor), shows only too clearly. Indeed, Phillips goes so far as to say that it must be accepted as an axiom (from the failure of Australian state-assisted projects) that no settler will ever succeed unless he takes full responsibility for the success of his venture.

The first chapter, by Herbert Burton, deals with immigration policy. During 1926 and 1927 prominent Australian statesmen were glibly stating that Australia could readily absorb 100,000 immigrants per annum. Yet it was found difficult to place 24,000 on the land each year, and all such assisted migration ceased in 1929 owing to adverse economic conditions. In the second chapter Professor K. H. Bailey makes clear that the opposition to British immigration avowed by many Australians is mainly due to the fact that the British immigrant, often of an unsatisfactory character, has in general been assisted by Australian grants of money. In Chapter 5 F. R. E. Mauldon, W. I. Potter, and A. G. Whitlam state that Australia already has

transport services of a capacity far greater than the business offering. There is an interesting discussion of the prospects of increasing Australia's export trade in spite of the long distances from the chief world markets.

In the *Geographical Review* for July, 1922, the reviewer published his forecast of a future Australian population of 65 millions. Since political boosters have mentioned 100 millions as the population "in a few generations," the former figure was distinctly not popular. Yet in Chapter 6 H. A. Mullett and S. M. Wadham arrive at about 65 millions from a consideration of the potential wheat belt, though they say elsewhere that between 40 and 50 millions seems more practicable. In Chapter 8 certain aspects of state policy are set out by F. W. Eggleston. His comparisons between the conditions of the settler in the early United States and in Australia are of much interest. In his opinion, the American environment was much more suited to the small farmer and the Australian to capitalistic development. Since he was formerly a cabinet minister, his frank criticisms of state control, dealing with overdevelopment, premature development, lack of coördination, etc., should be of interest to Americans at this juncture.

The last two chapters deal specifically with pioneer problems. A. S. Kenyon discusses settlement in the Victorian Mallee, and Gordon Taylor deals with group settlement in Western Australia. In the former area where a dense eucalyptus chaparral occurs the trees are "rolled down" and the land cleared at a cost of one or two dollars an acre. The stump-jump plow is used to prepare the land for wheat, and about seven bushels an acre may be expected in early years. By 1902 about four million acres of Mallee were under wheat, and by 1919 the remaining available land (two million acres) had been plowed. In 1930 more than half the state's total yield came from this area "so often condemned as outside the economic margin of settlement." The West Australian experiment has unfortunately been largely a failure. In 1921 the first group of farmers set to work to hew out a dairy farm in the wet southwest some 150 miles from Perth. By the end of 1931 the number of farms was only 1704, and these had cost the governments concerned 50 million dollars. The scheme failed because of faulty preparation, because the migrants were ill chosen, and because they "clung to a wages outlook" and often decamped when this was withdrawn. Altogether, this is a valuable book, dealing with data not readily reached by American readers.

GRIFFITH TAYLOR

DISCOVERY OF THE FIJI ISLANDS

G. C. HENDERSON. **The Discoverers of the Fiji Islands: Tasman, Cook, Bligh, Wilson, Bellingshausen.** xviii and 324 pp.; maps, ills., index. John Murray, London, 1933. 18s. 9 x 6½ inches.

Although the author's ignorance of the Dutch and Russian languages detracts somewhat from the value of his work, his careful study of the journals and routes of the early explorers in the Fiji archipelago makes a distinct contribution to the critical literature on Pacific exploration. Probably the most important feature of the book is the author's method of checking his authorities. While his general plan is to let each discoverer give his own account of his explorations, Professor Henderson has furnished a check by following the actual courses of the navigators. For this purpose he had the use of British and colonial vessels, generously supplied by the respective governments. His results prove the necessity of supplementing documentary sources by examination on the spot. He clears up many disputed points and supposed inaccuracies. "One now understands why the explorers mistook mountain peaks for islands and thought that open channels were blocked." The information given by these commanders in their charts and log books may be at variance with actual facts and nevertheless a true record of what they saw.

The author's close study fills him with whole-hearted appreciation of the "fearful risks" run by these early navigators. Of the explorers, the author naturally awards the leading places to Tasman (February, 1643) and Bligh (May, 1789, and August, 1792), but it is surprising to find that he gives the title of "the real discoverer of the islands of Fiji" to the latter because he made a more detailed examination than Tasman. Here and in other places one rather suspects the author's judgment of Bligh, whose courage and firmness on the boat voyage can hardly absolve him from his responsibility for the famous mutiny, which, like the later Rum Rebellion in New South Wales, his violence and temper did so much to create.

A. GRENFELL PRICE

DIARY OF JOURNEYS IN THE PUNA DE ATACAMA

WALTHER PENCK. **Puna de Atacama: Bergfahrten und Jagden in der Cordillere von Südamerika.** With an introduction by Albrecht Penck. 232 pp.; maps, ills. (Lebendige Welt: Erzählungen, Bekenntnisse, Berichte.) J. Engelhorns Nachf., Stuttgart, 1933. 7½ x 5 inches.

Twenty years have elapsed since Walther Penck completed his explorations in the Puna de Atacama for the Argentine government, and it is eleven years since his untimely death (compare *Geogr. Rev.*, Vol. 13, 1923, pp. 112–116). Now his father, Albrecht Penck, gives us the intimate details of those journeys and studies in an unknown land—Walther Penck's personal diary.

Here we find much that is new—observations not mentioned in his previously published writings; vivid descriptions of landscape seen in 17 months of intensive investigation in an uninhabited land concerning which our knowledge now, as then, is far from complete.

We follow the author's bell mare on the approach to the Puna from the south, through a dry valley with water holes 50 to 60 kilometers apart. Here the south winds blow, driving the sand into high drifts, which partially bury the bordering mountains. Dune succeeds dune; temperatures are 35° C. (95° F.) in the shade, 55.5° C. (131° F.) in the sun-scorched sands. Ahead are sandstone mountains with oddly indented walls. Beyond them looms the Puna, a high tableland with isolated snow-capped peaks. So clear is the horizon that each valley and each ridge of these 6000-meters-high volcanoes, though 150 kilometers away, is easily recognized. Later, however, as we journey towards the western rim, conditions change. Icy cold replaces the burning heat. There are acres of wind-ground stones, polished and glittering in the sun, but no more drifting sands. For here the west wind blows, and it can carry no sand across the high intervening frontier range.

We receive a vivid impression of the emptiness of this vast highland of ten thousand square kilometers. No humans, no animals, no plants, not even cactus—just bare stone and sand. For hours as Penck crosses those great thirsty stretches, 130, 150 kilometers in length, the scene never changes—always the same sterility, desolation, solitude.

Of outstanding interest are Penck's observations on the high mountain peaks, for, in general, the few who have attained heights of 6000 meters, or 20,000 feet, have written little of what was there. The old andesite volcano Bonete (6200 meters according to his determination) he found to be a magnetic south pole that repelled his compass needle. He draws an interesting comparison between the amount of soroche on San Francisco (6006 meters), where he felt the mountain sickness well down the slopes, and on Incahuasi (6639 meters), where he found it only at the top. Unfortunately no reason is advanced for this wide difference at two adjacent volcanoes under not dissimilar weather conditions. Both are old andesite masses, and the author apparently found no steam outlets or other remnants of volcanic activity

upon them; yet we wonder whether there might not have been carbon-dioxide emanations such as the reviewer has found to increase materially the soroche upon the more recent volcanic peaks a few hundred miles farther north.

Upon none of these volcanoes, nor upon the granitic Famatina, did he find moraines much below 5000 meters; in fact, their lower limit usually lay near 5200 meters. Where the weathered andesite above this level had been disintegrated into steep talus slopes by glacial action, he experienced considerable difficulty with that greatest of obstacles to passage above 5000 meters on Andean volcanoes, the rock slide. Another of the deterrents to travel at higher altitudes that the author mentions is the *nieve penitente*—remains of winter snows that by summer are converted to row upon row of icy teeth, 2 to 3 meters in height, in sheltered spots just below the 5000-meter level.

A narrative of travel in a desolate, uninhabited land might easily tend toward monotonous reading. The author saves his diary from this by continually pointing out the unusual. On Palca, for instance, above the 5000-meter level, amid all of the Puna's barren waste, he found tiny plants with delicate flowers, a butterfly, and—flies!

W. E. RUDOLPH

LLANOS OF THE ORINOCO

S. PASSARGE. **Wissenschaftliche Ergebnisse einer Reise im Gebiet des Orinoco, Caura und Cuchivero im Jahre 1901–02.** xi and 281 pp.; maps, diagrs. (Hamburgische Universität, Abhandlungen aus dem Gebiet der Auslandskunde, Vol. 39; Series C, Naturwissenschaften, Vol. 12.) Friederichsen, de Gruyter & Co., Hamburg, 1933. 11½ x 8 inches.

In a new volume dealing with a section of the humid steppe lands of tropical South America Passarge gives us in detail the results of a reconnaissance study in Venezuela over 30 years ago. This was an examination, made during the winter of 1901–1902, of the territory to the south of the Orinoco between the Caura and Cuchivero rivers. The volume is devoted largely to the physical geography and geology of the region, although plant morphology is given considerable space. Man, because of the sparsely settled nature of the country, is treated only briefly. Three-quarters of the book is devoted to detailed field notation—a method of treatment that, although preferable to too scanty a structural foundation, gives rise to considerable repetition. A chapter with a short summary at the end is devoted to each of the natural regions.

A long chapter presents the problems, chiefly geological and geomorphological, and the conclusions drawn by the author. The widespread unconsolidated sands and clays, as well as the laterite resulting from their alteration, that compose the steppes receive the greatest attention. Differentiation and correlation of such sediments, especially when unfossiliferous, as is the case in the region under consideration, are uncertain. The writer is fully aware of the difficulties and states the case fairly. A large proportion of the sediments composing the steppe plains is believed to have been derived from the mountains of northern Venezuela during the Tertiary (?) and Pleistocene. It is suggested that during a later transgression of the sea over the area studied these deposits were reworked and largely removed. The more humid climate of Recent ("Diluvial") time has caused the streams to aggrade and build up the steppes to their present form.

One of the most interesting interpretations deals with very recent geomorphological changes. The present streams are incised about 10 meters below the plain surface. Drainage divides are low and swampy, and anastomosing *morichales* (swamps whose characteristic vegetation is the moriche palm) are abundant. The author suggests a previous drainage pattern similar to that now in existence along the Orinoco-Amazon divide. There, in the country made famous by the writings of Humboldt, the relief is extremely low, divides are swampy and are often nonexistent during

flood water, and waters from the Orinoco basin pass continuously into the Amazon basin in at least two instances, notably in the Brazo Casiquiare. Such a drainage type is believed to have existed in the region studied.

Whereas the volume is of especial interest to the student of the physical geography of South America, it has a broader application to the processes taking place in a world-wide tropical steppe belt. It forms an admirable contribution to the scanty literature pertaining to a large, practically unknown section of South America.

C. B. HITCHCOCK

THE ILLINOIS PRAIRIE

EDITH MURIEL POGGI. **The Prairie Province of Illinois: A Study of Human Adjustment to the Natural Environment.** 124 pp.; maps, diagrs., ills., bibliogr., index. *Illinois Studies in the Soc. Sci.*, Vol. 19, No. 3; *Univ. of Illinois Bull.*, Vol. 31, No. 42, 1934.

H. C. M. CASE AND K. H. MYERS. **Types of Farming in Illinois: An Analysis of Differences by Areas.** Pp. 93–226; maps, diagrs., ills. *Univ. of Illinois Agric. Exper. Sta. Bull. 403*, 1934.

Miss Poggi gives a clear and well balanced account of the geography of an important section of Illinois. The Prairie Province is approximately the area in the state covered by the Wisconsin glaciation. "The level topography, the thick morainic soil, and the accumulation of decomposed prairie vegetation make this excellent crop land, some of the richest in the United States. The climate—particularly the long hot summer, with adequate rainfall—offers optimum conditions for corn, which early became, and still is, the chief money crop. . . . Finally, the location of the province with regard to Chicago—the great industrial center and land-and-water terminal—assured a ready market and exit for the produce of the region."

The Prairie Province was the last part of Illinois to be settled. "Not until the railroad was built across the east-central part of the state did the settlers leave the river banks for the prairies," but once their fertility was realized development was rapid.

An excellent feature of the monograph is the broad setting given to the several elements analyzed; for instance, the 3-page discussion of the causes of prairie vegetation. Maps and diagrams are numerous and well selected.

Supplementary maps and agricultural data are to be found in the types-of-farming study by Case and Myers. Their "cash grain" division is largely coincident with Miss Poggi's Prairie Province. Two-thirds of all the farms in the area were classed as grain farms in 1929.

A JOURNEY IN MAURITANIA

MICHEL VIEUCHANGE. **Smara: The Forbidden City; Being the Journal of Michel Vieuchange while Travelling among the Independent Tribes of South Morocco and Rio de Oro.** Edited, with Introduction and Epilogue, by Jean Vieuchange. Translated from the French by Fletcher Allen. xii and 276 pp.; map, ills., index. Methuen & Co. Ltd., London, 1933. 8s. 6d. 7½ x 5 inches.

Smara is a small fort in the Spanish colony of Rio de Oro in Mauritania. To it a young Frenchman, Michel Vieuchange, made a journey in 1930. To understand the tragic outcome that cost his life one must understand the political state of Mauritania. It is cut up by frontiers: not only that of Spanish Rio de Oro—French Mauritania itself is divided among three different administrations, the Moroccan protectorate, the Algerian Sahara, French West Africa. These administrative boundaries are scarcely less watertight than the Spanish frontier.

The Algerian Sahara and French West Africa have camel corps, and to these Smara has been for some time a forbidden city, but only theoretically or diplomatically. It is true that they have not the right to go into Spanish territory, since they are French soldiers. But Smara is very near the frontier, which is not marked on the ground. The tribesmen of Rio de Oro are plunderers, and in engagements with them the French police forces sometimes have forgotten that they have not the right of pursuit into Spanish territory. Furthermore, the tribesmen who live in French territory have their private wars with those who live in Spanish territory. A detachment of the camel corps penetrated to Smara in 1913. To pursue the study of Smara and other connected Mauritanian questions of keen interest, Michel Vieuchange need only have followed the corps. Unfortunately he was living in southern Morocco. The Moroccan protectorate, too much occupied with matters north of the Atlas and in the region itself, has not yet undertaken a Saharan policy and has not a single meharist. Michel Vieuchange was twenty, impetuous, ingenuous, devoted. He steeped himself in Arabian and Barbary legends; he did not know that, in the Sahara, the era of René Caillié and of individual explorations is a thing of the past.

And that is why we have lost in him a young man who would perhaps have done great things. One well understands that his family should have wanted to perpetuate his memory. This heart-rending episode has a romantic flavor that the English-speaking public apparently appreciates.

E. F. GAUTIER

SEQUEL TO "TUDOR GEOGRAPHY"

E. G. R. TAYLOR. **Late Tudor and Early Stuart Geography, 1583–1650.** ix and 322 pp.; ills., bibliogr., indexes. Methuen & Co. Ltd., London, 1934. 15s. 9 x 6 inches.

The "core" of Professor Taylor's second volume is, as she says, the bibliography. For the first time the geographical literature of the period has been listed, to the number of some two thousand items, printed and manuscript. Their range is extensive—from drainage plans to reports of earthquakes, from atlases and travel collections to pamphlets on trade. The compiler's industry was prodigious, and the result is admirable. One who has profited by the work before its publication must regret that the manuscript items are, for reasons of expense, left unlocated and thus in a manner reinterred.

The text is a compact and illuminating survey of the geographical literature and its authors. On the whole it is not a story of success. Hakluyt, whose geographical "motivation" rather than achievement is stressed, left rather the "raw material of History and Geography" than a body of knowledge. Purchas's "Pilgrimes" is "an 'omnibus' book of giant proportions" and "a double though a gallant failure." The Tudor-Stuart period saw in geography mainly political information, little of physical geography or of environmental study. Chorography, or regional geography, was most interested in history and antiquities; surveying was ineffectual. Purchas's "Pilgrimage" was, however, a striking attempt at a synthesis of human geography; Carpenter's "Geography" (1625) was an important and "modern" work in general geography. There was much interest and activity in mathematical geography, mainly in the interests of navigation, but the "seamen as yet were not mathematicians, and the mathematicians were not seamen"; progress here was a matter of detail. The study of nature hardly "represented an advance on Pliny." Economic geography was descriptive and factual. Finally, with Heylyn's "Cosmography" (here dated 1649, though I know of no edition before 1652) "geography had fallen back into the position of a mere adjunct to Mathematics and History, written, not by professional geographers, but by scholars and divines." Only the Royal Society could save the science.

These generalizations of the author seem to state her idea of the historical development, which is not too clear. It appears now that the history of geography in England can be understood only in relation to its history in Europe as a whole. Miss Taylor often suggests such comparisons: referring to the Dutch navigators, to the "systematization of geographical knowledge among Jesuit teachers," to Varenius. Other continental work that comes to mind is the "chorography" and cartography of the Low Countries, the Elzevir compilations on separate countries, the continental travel collections. Perhaps against this background the English scientists would seem a little more significant.

GEORGE B. PARKS

THE CIRCUMNAVIGATION OF THE "NORVEGIA"

GUNNAR ISACHSEN. **"Norvegia" Rundt Sydpollandet: Norvegia-Ekspedisjonen 1930–1931.** 253 pp.; maps, diagrs., ills., bibliogr., index. (Kommandør Chr. Christensens Hvalfangstmuseum, Sandefjord, Publ. No. 15.) Gyldendal Norsk Forlag, Oslo, 1934. 9½ x 6½ inches.

In the January, 1932, number of the *Geographical Review* Major Isachsen described the Antarctic circumnavigation of the *Norvegia*. In this volume he gives the complete story in diary form, with setting and results. The primary purpose of the trip was oceanographical study in Antarctic waters. Deep-sea soundings were made at 54 stations, at each of which detailed data were obtained and, since the vessel was equipped with a sonic depth finder, at many other points also. Samples of water were collected at depths ranging from 1000 to 3000 meters, and readings of subsurface temperatures were made. The density of the water and its salinity were determined at various depths for most of the stations. As instances we may quote from readings taken at 61° 10′ S. and 111° 51′ W. The relation of the density of the sea water to depth was:

Surface, 1.02716; 1000 m., 1.03247; 2000 m., 1.03739; 3000 m., 1.04211.

The temperature fluctuations at the same station were:

Surface, 2.81°; 100 m., 2.53°; 150 m., 1.60°; 600 m., 2.28°; 3000 m., 1.01°.

The salt content per mille was 34.05 at the surface; from 10 to 100 meters, 33.99; then to a depth of 2000 meters a steady increase to 34.74.

Another of the objectives of the expedition was to search for various doubtful islands—Truls Island, the Nimrod Islands, Dougherty Island. As Major Isachsen has already reported, a thorough but fruitless search was made in each instance, and it seems proved beyond reasonable doubt that the islands are nonexistent.

The closing chapter deals with modern pelagic whale fishing in the Antarctic waters and gives much material of high value to those engaged in the whale-fishing industry.

The merit of "Norvegia Rundt Sydpollandet" lies not only in its scientific observations but also in the interesting style of its narration, by which the reader can relive every day of the voyage. The details of life on board, of difficulties of weathering storms and of making repairs at sea, as well as the personal reactions of various members of the crew, are faithfully and, in many instances, humorously recorded.

NELS A. BENGTSON

THE ANCIENT WHALE FISHERIES

BJARNE AAGAARD. **Den Gamle Hvalfangst.** 167 pp.; maps, ills., bibliogrs., index. (Kommandør Chr. Christensens Hvalfangstmuseum, Sandefjord, Publ. No. 13.) Gyldendal Norsk Forlag, Oslo, 1933. 10 x 6½ inches.

This résumé of early whale fishing was originally intended to form a part of the author's "Fangst og Forskning i Sydishavet" (reviewed in the *Geogr. Rev.*, Vol. 21, 1931, pp. 516–517). It presents a carefully documented discussion based on numer-

ous sources, both primary and secondary. In the first chapter the earliest evidences of whale fishing are treated in some detail. The existence of whales during the Ice Age is claimed to have been proved by the author's discovery in 1914 of a fossil whale near Rækevik in Larviksfjord. The earliest picture of a whale is one on stone found on the island of Crete and is believed to date back to about 2000 B.C. That whales were often seen in the Mediterranean Sea and in the Persian Gulf seems attested by numerous credible accounts. The first authentic reports, so far discovered, of whale fishing along the Norwegian coast date back to 417 A.D.

The following chapters deal rather fully with the whaling activities of the Basques, British, Dutch, and Americans. The story of the gradual retreat of the whales in the face of increasing efficiency of European and American seamanship and industrial zeal is well outlined. Especially commendable features of the book are the numerous reproductions of old drawings, paintings, and maps, which help to clarify the text. An extensive bibliography of books and articles in various languages dealing with the history of whaling is included; this alone is a valuable collection for anyone seeking information concerning an industry of long standing and of world-wide importance.

NELS A. BENGTSON

A HISTORY OF THE EAST GREENLAND ESKIMOS

EJNAR MIKKELSEN. **De østgrønlandske Eskimoers Historie.** 202 pp.; map, ills., bibliogr. Gyldendalske Boghandel, Nordisk Forlag, Copenhagen, 1934. 9½ x 6¼ inches.

An interesting résumé of the present state of knowledge concerning the early inhabitants of the northern part of Greenland's East Coast is given in the first chapter. Dr. Therkel Mathiassen's claim that the Eskimos first came to eastern Greenland from the southwest and reached Angmagssalik (65° 30′ N.) about 1400 A.D. is accepted as valid. From Angmagssalik the Eskimos gradually pushed northward and probably reached the vicinity of Danmark Harbor (77° N.) a century later. Soon afterwards they encountered there a group of Eskimos evidently from the same homeland but who had traversed the north coast on their way eastward. Because of their long journeyings under radically different environmental conditions both groups had acquired skill and customs in keeping with their environmental problems. The Eskimos from the south, where open coastal waters are characteristic of the summers, had become expert in handling kayaks and in open-sea fishing with them; those from the north, where the coast is virtually always frozen, had become skilled in handling dog sleds and in the problems of hunting on the ice.

In the following chapter the causes of disappearance of the northeasternmost Eskimos are discussed. Conditions of life were hard; at times there was not enough blubber for food and oil; when the season's hunt was unusually meager, older folks often committed suicide, and infants were deliberately put out in the cold to perish. Superstition had a strong hold, and often sacrifices were made to appease gods believed to be angry. Although under the practically impossible conditions prevailing in northeastern Greenland we might assume that migration southward to less hostile shores would have resulted, no traces of such a movement have been discovered. The evidence seems to warrant the belief that the earliest Eskimos into northeastern Greenland were gradually but completely destroyed by the elements that they could not overcome.

After relating the early history of the wanderings of the Greenland Eskimos in their struggle for existence, the author gives carefully prepared descriptions of the present inhabitants of the various parts of the country. The relationships of customs and modes of life to the environmental factors are stressed throughout. The sources of food supply and the methods of hunting and fishing are discussed in considerable

detail. In reading this book one is impressed with the fact that the Eskimos live by adjusting themselves to their stern environment and only in small degree by overcoming it. As a result of careful investigations made during the past two decades the Danish government is able to be of real assistance to the natives of Greenland in their quest for sustenance and better cultural standards. The author is well qualified for his task. His book, well written and illustrated, is a valuable addition to a rapidly growing literature on Greenland.

NELS A. BENGTSON

WHITES AND ESKIMOS IN NORTHERN ALASKA

ROBERT MARSHALL. **Arctic Village.** xii and 399 pp.; maps, ills., indexes. Harrison Smith and Robert Haas, New York, 1933. $3.00. 8½ x 6½ inches.

ROBERT MARSHALL. **Reconnaissance of the Northern Koyukuk Valley, Alaska.** Map. *U. S. Geol. Survey Bull. 844-E.* 1934.

Readers will differ as to why "Arctic Village" is so interesting a book, but interesting it is. Marshall, a good observer, tells all about almost everything at Wiseman, becoming, on occasion, Rabelaisian. Its comprehensiveness may make its interest—the picture of what is going on up there north of the Arctic Circle is so complete. The author says these people "have made for themselves the happiest civilization" he knows of. But the reviewer thinks they have never made a civilization at all.

Singularly chosen actors on this stage—two utterly alien groups, primitives in transition and moderns. But the primitives are a social unit—50 natives of whom half are females and half under the age of 21; the moderns are an impossible group of 77 whites, a tenth of them females and none of them under 21—no unit at all, mere fragments from a civilization far away to the south.

The Eskimos have lost their mastery of their environment. Probably they could not now subsist as their fathers did one generation back. The economic background of the whole settlement is the need distant white men feel for gold and furs that the Koyukuk can supply and the food, weapons, and tools they send in exchange and on which the Eskimos are utterly dependent.

The happiness of the whites is that of carefree adults without the burden of family. But civilizations have always been built on the unhappiness of parents struggling to protect and guide their young. The whites of Koyukuk know nothing of this. They live for themselves. As individuals they have a sort of mastery of their environment and pleasure in this mastery, for the environment is hostile. They are good fighters and ready friends.

The Eskimos, for all their dependence on a white civilization, which they know only by some of its material products, come out the heroes of the piece. They are remarkable in transition. But there is little chance they can endure in the civilization that swept them in one generation out of a past ten thousand years away from today.

A map of the northern Koyukuk region, based in part on the author's own surveys, is published in his reconnaissance report for the United States Geological Survey.

MARK JEFFERSON

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